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NIGERIA

Annual Report on the Agricultural Department, Nigeria for the year 1951-52

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INSPECTOR-GENERAL OF AGRICULTURE,
LAGOS.
8TH JANUARY, 1953.

THE HON. MOHAMMADU RIBADU, M.B.E.,
MINISTER OF NATURAL RESOURCES,
LAGOS.

SIR,

I have the honour to submit for your consideration, my Annual Report for the year 1951-52.

I have the honour to be, Sir,

Your obedient Servant,

A. G. BEATTIE,
Inspector-General of Agriculture

FOREWORD

By

THE HONOURABLE MOHAMMADU RIBADU, M.B.E.,
Central Minister of Natural Resources

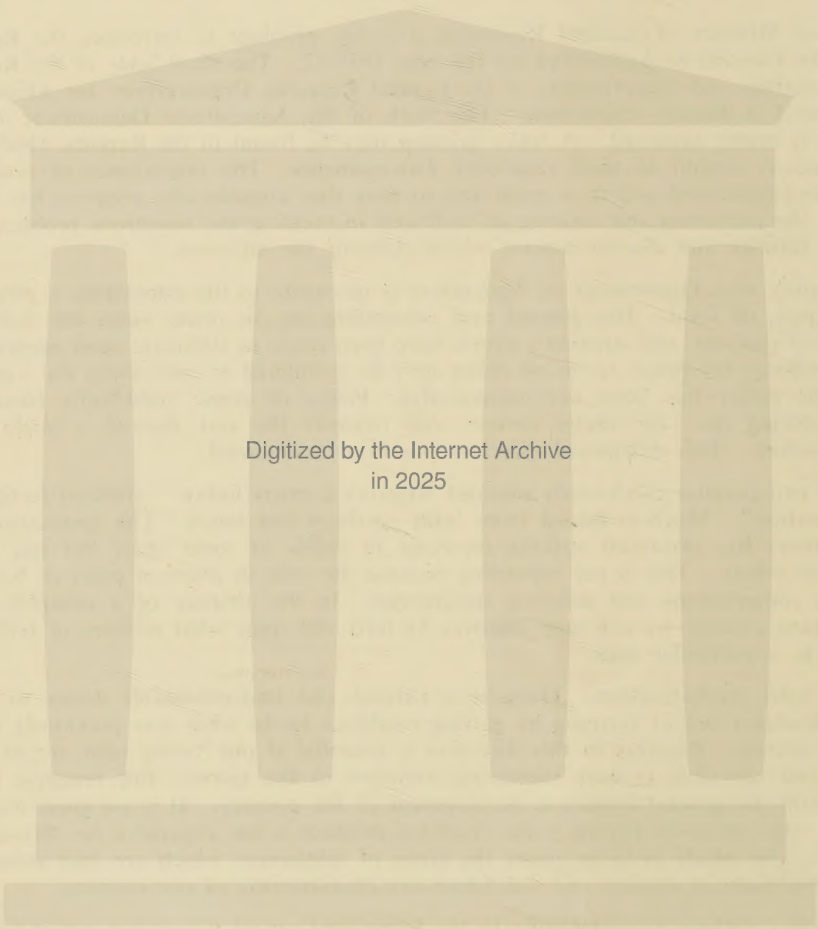
As Central Minister of Natural Resources it is my privilege to introduce the Report of the Inspector-General of Agriculture for the year 1951-52. The main body of the Report surveys the activities and achievements of the Central Research Organisation, for which the Inspector-General is directly responsible. The work of the Agricultural Department in the three Regions is briefly reviewed. A fuller account may be found in the Reports which the Regional Directors submit to their respective Governments. The importance of research cannot be over-emphasised and it is gratifying to note that considerable progress has been made both in the recruiting and training of staff and in tackling the numerous problems of breeding, soil fertility and disease control which clamour for attention.

The first duty of a Department of Agriculture is to ensure to the population a plentiful and cheap supply of food. The general and continuing rise in prices since the war has been a source of concern, and strenuous efforts have been made to stimulate food production so that the tendency for prices to go on rising may be countered by increasing the supplies available. This policy has been not unsuccessful. Prices of staple food-stuffs remained fairly stable during the year under review, and towards the end showed a slight but encouraging decline. This downward direction has been maintained.

There are two popular catchwords amongst Nigerian farmers today—"artificial fertiliser" and "mechanisation". Much is hoped from both—perhaps too much. The application of artificial fertilisers has produced striking increases in yields in some areas but has been disappointing in others. This is not surprising because the soils in different parts of Nigeria have differing compositions and differing deficiencies. In the absence of a complete soil map of the whole country we can only discover by trial and error what mixture of fertiliser is best suited to a particular area.

Similarly with mechanisation. There is a natural and understandable desire to take some of the drudgery out of farming by getting machines to do what was previously done by sweat and muscle. Progress in this direction is essential if our young men are to stay on the land and not drift in ever increasing numbers to the towns. But progress must keep in step with the general economic development of the country. It is no good making a machine do what man did before if the resultant product is too expensive for anyone to buy. We have also much to learn about the types of implement which are best suited to the arduous conditions of climate and soil which are characteristic of our country.

I cannot close without paying tribute to the Inspector-General whose last report this is. Mr Beattie, after nearly thirty years of devoted service in Nigeria, has put down the burden of office and left the country on retirement. He leaves behind him, besides numerous personal friends, a Department which is a memorial to his ability and farsightedness. We all wish him many years of continuing health and happiness.



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Annual Report for the Year 1951-52 by the Inspector-General of Agriculture

INTRODUCTION

The pages which follow contain a brief description of some of the events of agricultural importance which have occurred in each of the Regions during the year under review. The main body of the Report constitutes a record of the activities of agricultural staff forming the Central Research Organisation for which I have direct responsibility. The record of these activities has been compiled by the Research Adviser ; and because of its particular agricultural importance to Western and Eastern Regions in particular, a special report is included of the activities of the Oil Palm Research Station.

Since this Annual Report is the first one prepared since the post of Inspector-General of Agriculture was made, I venture to set out below a brief indication of some of the duties and activities connected therewith.

The Inspector-General is responsible for advising the Nigerian Government through the Central Minister of Natural Resources, upon all agricultural subjects which are common to all the Regions. All Regions are vitally interested, for example, in the maintenance of fertility by the use of artificial fertilisers, and in the development of mechanisation.

They are all interested in certain special industries, such as the production of sacks for the export of produce. In this example, it falls to the Inspector-General to advise on the co-ordination of Regional efforts aimed at producing suitable kinds of fibre for the manufacture of these sacks, in other words, to assist in the production of raw material for new industries.

The Inspector-General is charged with Agricultural duties of International or Inter-colonial interest. He is a member of the four Commodity Marketing Boards in Nigeria, dealing with Oil Palm Produce, Groundnuts, Cocoa and Cotton. In addition, he is a member of the Managing Committee of the West African Cocoa Research Institute and West African Institute for Oil Palm Research. He is Chairman of the Nigerian Board of Agriculture, and as such is responsible for advising Government on Agricultural legislation. One particular aspect of this responsibility consists of the necessity for the safeguarding all Regions of Nigeria against the introduction of plant diseases and pests.

During the year under review, the Department of Statistics prepared a Sample Census of Agriculture, in the preparation of which Agricultural staff in all Regions took a prominent part.

A sketch description of the internal organisation of the Department and a Financial Account are presented with this Report.

NORTHERN REGION

The Northern Region experienced one of the best growing seasons on record, and this was reflected in the very heavy purchases of groundnuts which amounted to 418 255 tons, as compared with 142,743 tons in the previous season ; and purchases of cotton lint which amounted to 106,080 bales, as compared with 74,832 bales in the previous season.

In addition to the crops mentioned above, which were purchased by the Marketing Boards, it is of interest to record also that the Boards purchased during the season 10,387 tons of beniseed, and 7,970 tons of soya beans. This was more than double the quantity of soya beans purchased in the previous season.

In spite of lamentable staff shortage in the Region, the Department endeavoured to discharge its responsibilities over a wide range of activities including the distribution of improved seed, in the supervision of a rapidly expanding mixed farming industry, in the production of high-yielding strains of milk-cattle, investigations into the economics of mechanical cultivation, and the construction of various minor irrigation projects in the Sokoto and Niger Provinces.

Food Prices

It was noted that in several of the Northern Provinces in the last quarter of 1951, a general fall in grain prices took place. For example, in Daura where the price for guinea-corn in September 1950, was £27 10s per ton, it was only £11 14s per ton in September of 1951.

Livestock

The numbers of animals in herds of cattle maintained at Government farms in the Northern Region, were in September 1951, as follows :—

Shika	Total herd :		663
Maiduguri	„	„	120
Samaru	„	„	199
Kano	„	„	60
Daudawa	„	„	265

At Shika, the highest completed lactation for any cow up to that date was 5,466 lbs in 350 days. There were during the year, four lactations of over 4,000 lbs and eight of over 3,000 lbs. At Shika also a total stock of 370 pigs was maintained.

Poultry stocks for multiplication and distribution were maintained at the Samaru School, at Gusau, Ilorin, Riyom, Yandev and at Sokoto.

Pasture

Observation and establishment of plots of various grasses and legumes were continued at most stations throughout the year. These included Yola, Maiduguri, Kano, Gusau, Riyom, Sokoto and Ilorin.

At Maiduguri, it was shown that ten acres of natural pasture on the farm were adequate for a pair of bullocks, but that five acres could not maintain condition throughout the year. On the five-acre plot, it was essential after nine months of grazing between May and January, to supplement grazing with about 3,000 lbs weight of hay, which represented the yield from about three-quarters of an acre. It was concluded that in this Region, four acres was the minimum required to maintain an adult beast throughout the year.

Maize Rust disease *(Puccinia polysora)*

Maize Rust was prevalent through a large part of the Northern Region, and from the Niger Province it was recorded that there was much Rust in the Abuja and Kontagora areas. From Yandev in the Benue Province, it was reported that Rust was particularly severe and that in some cases yields had been reduced by 60 per cent.

Other crops

There was a general increase in the production of Cassava throughout the Region, and from Gusau it was reported in September, that supplies were good and that prices had fallen from £8 to £5 per ton. It was reported from Yandev that a yield of beniseed of 391 lbs per acre was obtained at the Government farm, and that this was the highest recorded in the six-year period from 1945. Yields of Mucuna hay at the rate of 15,000 lbs per acre was recorded from Ilorin.

Local firms offered a price of £37 6s 8d per ton for Castor seed, and the 1951 crop purchased amounted to 7,503 tons compared with just over 4,000 tons in the previous year.

At the annual ginger market at Maigana, a total of 57 tons of ginger was purchased.

It was reported from Kabba Province that one unit farm yielded yams at the rate of 14,880 lbs.

A yield of 4,524 lbs of cowpea hay per acre, was obtained at Samaru.

Local Industries

It was reported from the Maigana area in Zaria Province, that 287 sugar-mills were operated. At Maigana, seven varieties of sugar-cane were planted in a variety trial. At this station, record yields of over 29 tons of cane per acre were obtained. In Kano Province, it was reported that 182 mills were in operation.

Agricultural Shows

Two shows were held in Adamawa Province in February of 1952 at Jada and at Mubi. In Sokoto Province, shows were held during the same month at Argungu, Yelwa, Bagudo, Sokoto and Birnin Kebbi. The annual Cattle Show at Kaiama in Ilorin Province was held in October.

Mixed farming

The price of cattle for distribution to mixed farmers remained high. The average price of a five-year old working beast was reported to be £14 at Daura in early 1952. Some 215 head were purchased in the year, for issue. At Kano, 364 working cattle for mixed farmers were purchased in 1951, at an average price of 4s 9d per lb.

Some misgivings were felt at the high incidence of Trypanosomiasis and the reappearance of *G. Morsitans* in the Anchau Corridor in the Zaria Province.

Mechanical cultivation

Experiments were continued on all tractor unit farms in the Region ; and new implements introduced to the Agricultural Engineering headquarters at Samaru included a grain and fertiliser drill, two threshers, two terracers, one groundnut picker, one pick-up baler, and two sets of bulldozing equipment. Special schemes for mechanical cultivation in low-lands were developed at Yola, Maiduguri and Yandev. The Northern Regional Production Development Board were successful in completing the ploughing of more than 25,000 acres in Sokoto Province during the year.

Irrigation

Several small schemes were developed in the Sokoto Province, and the third Sokoto training course was finished in July of 1951 ; the fourth course consisting of eleven students was commenced in September. Development of two schemes in the Niger Province at Wuya and Badeggi was continued.

Fertilisers

The Chemist recorded that the residual effect on groundnuts of superphosphate applied to guineacorn at Kano in 1947, gave significant increases in yields for four years in succession. The rate of application of the superphosphate to the guineacorn was 50 lbs per acre. The residual effect was reflected in a total increase of groundnuts of 901 lbs. At £25 per ton, this was valued at £9 6s.

The increase of guineacorn in 1947 resulting from the 50 lb application of superphosphate amounted to 341 lbs of grain valued at 2d per lb equalling a total return of £2 17s. The cost of the superphosphate was estimated to amount to 11s and that the total profit over the five-year period amounted to £11 12s per acre.

WESTERN REGION

Staff

The shortage of Senior Service staff continued to be acute, and indeed deteriorated towards the end of the year with the secondment of three Officers to duties outside the Regional Department. Nevertheless, essential services were maintained and the Department continued to be organised in two main divisions—one dealing with the problems of the Cocoa industry including rehabilitation with alternative crops, and the other concerned with the general agricultural development of the Region.

The Season

Rainfall, though rather above average, was not well distributed, the rains being somewhat late in starting and early in finishing. However, production of food crops was satisfactory, and increased acreages of most staple foods were recorded.

Maize Rust disease was not as serious as in 1950-51, and only fields which were late planted suffered severely. Purchases of cocoa, palm oil and palm kernels for export, declined compared with the previous season; whereas production of Hevea rubber and tobacco increased with improved prices and demand.

Departmental Farms and Training

Provincial farms and Native Authority farm Centres continued to operate as centres for dissemination of knowledge, improved planting material and stock. In addition to the Farm Schools at Oyo and Ogbomosho, parts of which were adapted for the use of mechanical cultivation, a three months training course in poultry husbandry was conducted at Fashola Stock Farm; and shorter practical courses were organised at Agege and Benin.

The new Akure Government Farm, planned as a large scale demonstration of modern mixed farming techniques was further developed, particularly as regards permanent crops. Towards the end of the year, a site was selected in Warri Province, for a provincial farm.

Animal Husbandry

The main animal husbandry work of the Department continued to be centred at Fashola Stock Farm in Oyo Province, where the N'dama herd made satisfactory progress both as regards health and numbers. A start was made with fencing and pasture improvement of this farm. Herds of West African short-horn cattle being graded up by the use of N'dama bulls, were maintained at most Government and Native Authority farms; and the issuing of bulls to improve village herds was extended.

The Agege and Moor Plantation Urban dairies continued to operate, but it was apparent that the economics of milk production would never be satisfactory until higher-yielding cows became available. In view of this, and the difficulty of obtaining good quality local stock, it was decided to introduce exotic blood to up-grade the Zebu stock for urban dairy schemes.

Pigs of the Large White breed were maintained in excellent condition on thirteen Government and Native Authority farms, for the provision of breeding stock, and for demonstration and teaching purposes. However, the high cost of feeding stuffs made the economic operation of piggeries impossible, except in places where there is a market for meat at luxury prices; and private piggeries were, in the main, unsuccessful. The Department maintained three depots to provide feeding stuffs for pig keepers.

The Department's poultry programme was based as formerly on the Rhode Island Red breed, and at the two main poultry stations at Fashola and Agege. From the former, breeding stock is still distributed over the whole territory, while the latter station serves as a safeguard against serious disease at Fashola.

The Fashola stock did exceptionally well during the year, and ten imported cockerels were acquired for the two stations, to maintain the quality of breeding stock.

Western Regional Production Development Board

The Department continued its assistance to the Western Regional Production Development Board in respect of planting material, supervision and technical advice for the development of its Agricultural projects. The Board placed mechanical equipment at the disposal of the Department, to assist in schemes devised and operated by the latter.

The Soil Survey section of the Cocoa Division conducted a semi-detailed soil survey of the Board's Apoje project, to facilitate land use planning.

Mechanisation

There was considerable development in the use of mechanised cultivation in the Region, particularly by the Western Regional Production Development Board, and the Department continued to test equipment under conditions typical of the Region. In addition, the Regional Mechanisation Organisation which is still based on Fashola, maintained equipment for Government Farms, and provided equipment and supervision for Mechanised Group Farming Schemes at Shaki, Eruwa and Ikonofin.

School of Agriculture

During the year, a new course for Field Overseer grade staff was introduced, and as a result of this and the admission of two Agricultural Assistant classes, a record number of 124 students was in training. No Agricultural Assistants were posted during the period under review, as the former year's group went out earlier than usual, in March 1951. Of a total of twenty-three Agricultural Assistants admitted to the three Agricultural Assistant Officers' classes, only ten remained at the end of the year, the others having failed in examinations, or secured admission to the University College, Ibadan.

Cocoa Division

Steady progress was maintained with the Cocoa Survey, although somewhat slower than was hoped because of the discovery of large blocks of hitherto unsurveyed cocoa. A small new centre of swollen shoot disease near Ife was successfully treated, and the other isolated outbreaks in Abeokuta Province are now considered to be under effective control. The policy of sealing off the area of mass infection in the Ibadan Division, and abandoning cutting-out in this area, was continued. Within this cordon sanitaire, it had become clear that control measures were unlikely to succeed and attention was, therefore, directed toward confining the disease.

In connection with the rehabilitation work in the devastated area, soil surveys were in progress to determine the suitability or otherwise of different areas for replanting the cocoa. Where such replanting is considered advisable, it is proceeding in an orderly manner designed to facilitate future development of the industry; and in areas where replanting of cocoa is considered impracticable, alternative crops such as Citrus and Oil Palms are being developed.

EASTERN REGION

Staff

A very modest improvement in the staff position took place during the year, there having been twenty Senior Service officers at the end of the year, as against sixteen at the beginning. This improvement should be viewed, however, against a total establishment of thirty-one, with eleven unfilled posts.

Rice

The most spectacular Agricultural development in the Region has been the rapidly expanded cultivation of rice. The area producing rice is estimated conservatively at more than 40,000 acres. This considerable expansion has taken place without the aid of mechanisation. Yields of rice in experimental plots of Tidal Mangrove swamp have reached to over one ton of paddy per acre.

Eastern Regional Production Development Board

The Department placed at the disposal of the Production Development Board, all available cashew seed for the planting of the Board's new plantation of this crop. Surveys by Agricultural staff were carried out to assist the Board to reach decisions concerning the establishment of cocoa and oil palm plantations.

Agricultural Farms and Training

Agricultural training courses for private persons, varying in length from six weeks to twelve months, were given at all Government Departmental farms. A site for a new station in the Cameroons Province was chosen at a point 8 miles south of Kumba. With this, there is now a provincial farm in each province of the Region, with the exception of the Rivers Province. Demonstration Farm Centres are established at nine places in the Region.

The Season

Rainfall was generally satisfactory despite anxiety in some parts because of light early rains. Rust disease on maize led to short supplies in some Southern districts. An indication of the satisfactory food position, however, is reflected by the gradual increase in the railings of dried cassava ("garri") to the Northern Region. Railings increased from 16,000 tons in 1948 and 1950, to 25,000 tons in 1951.

Animal Husbandry

A herd of Zebu cattle is maintained at Bambui farm in Bamenda Province, where the policy of breeding to produce an animal suitable for local mixed farmers was continued. Three herds of West African Short-horns are maintained at Abakaliki, Umudike and Nkwelle : and breeding flocks of sheep are maintained at Abakaliki and Umudike. Improved stock from these herds and flocks are made available to local farmers under suitable conditions. Pigs thrive on Government farms throughout the Region, but are issued to farmers only under strict conditions of sanitation and housing.

Flocks of Rhode Island Red poultry and Muscovy ducks have been maintained satisfactorily ; and particular success has resulted from experiments with the maintenance of Muscovy ducks under natural conditions at Abakaliki, Umudike and Nkwelle.

Soil Fertility

Throughout the Region, some 45 tons of mixed artificial fertiliser was used for demonstration purposes, usually on farmers plots of one-tenth acre. Much publicity has been given to the results obtained, typical examples of which can be seen in the table below :—

Area	*No. Plots weighed*	*Yield of yams in lb/acre fertilised plots*	*Non-fertilised plots*	*Increased yield*	*Value of increase*
					£ s d
Afikpo Division	49	11,584	8,235	3,349	14 4 0
Abakaliki	25	4,915	3,225	1,690	7 3 4

The fertiliser used cost £4 per acre.

Increases in yields of 25 per cent to 35 per cent due to fertiliser were common in Calabar Province.

Oil Palm Cultivation

Some 700 000 improved Oil Palm seeds were supplied by the West African Institute for Oil Palm Research. This was expected to suffice for the planting of some 6 000 acres of new plantations in 1953.

Agricultural Engineering and Soil Conservation

An engineering workshop was completed at Abakaliki at which tractors and machines under test throughout the Region can be distributed, and to which they can be returned for repair. All Experimental Farms and Demonstration Farms have been planned in such a way as to show the benefits of terracing, contour ploughing, and planting to conserve the soil.

Market Gardening

The Pilot Urban Market Garden Scheme was completed at Enugu, and has been utilised successfully as a training ground for selected persons from all parts of the Region. Many African market gardeners have copied the methods practised at the Pilot Scheme.

OIL PALM RESEARCH STATION

This was the last year in which the Oil Palm Research Station formed part of the Agricultural Department. In April 1952, it became the West African Institute for Oil Palm Research which was established by Ordinance to serve the needs of the territories of Nigeria, the Gold Coast and Sierra Leone.

Administration and Staffing

The administration of the station was much assisted by the appointment of an Executive Secretary who arrived in May. In August an Engineer arrived to take charge of the construction programme and he was assisted for part of the year by an Inspector of Works. The posts of Plantations Manager and Station Superintendent were both filled throughout the year, though the Plantations Manager was on leave during the summer of 1951.

On the research side, the staffing position was also much improved, as can be seen from the table below :—

	March 1951	*March 1952*	*Establishment*
Principal Research Officer	—	1	1
Agronomists	1	1	3
Plant Breeders	1	2	3
Chemists	—	1	2
Pathologists	—	1	2
Physiologist	—	—	1
Statistician	—	1	1
Horticulturist	—	—	1
Temporary Research Officers	2	2	2
	4	9	16

The Junior Service staff increased from sixty-nine to seventy-four. The approved establishment is 120. An Assistant Agricultural Officer was undergoing training at the Royal Botanic Gardens, Kew, during the year.

Labour

The serious falling off in the strength of the labour force which started in the last quarter of 1950 continued through the first half of 1951 and as a result of this the maintenance work fell very far behind-hand, only a very small planting programme was undertaken and the size of the nursery was reduced by nearly a half. During the latter half of the year, however, a recruiting campaign in the East bore fruit and by January the numbers were back to normal.

Finance

The station continued to be financed by the grant of £530,608 from the Nigerian Oil Palm Produce Marketing Board which covered the three-year period 1st April, 1949, to 31st March, 1952.

Construction Programme

Owing to the lack of supervisory staff, the construction programme fell greatly behind schedule and by the end of 1951, not more than half the capital works required were completed. Fair progress was made at the sub-station, Abak, where, by the end of the year, one Rest House, two C-type and ten D-type quarters had been completed and ten further D-type quarters were under construction.

Considerable difficulties were met with in the installation of a satisfactory water supply. New engines which were installed during the year gave continuous trouble and it was not possible to make a start with the erection of the new 100,000 gallon overhead storage tank.

Planting

In 1951, 8.1 acres were planted at the Main Station, 25.5 acres at the sub-station, Abak, and 5.0 acres were replanted at Umudike. Preparations were made to plant over 200 acres at the Main Station in 1952 and 245 acres were actually under-brushed. The programme has, however, been reduced to about 120 acres.

Yields

The average number and weight of fruit bunches per acre harvested during 1950 and 1951 from areas planted at normal spacing are shown below :—

Year of planting	*Area acres*	*No. of bunches per acre*		*Weight of bunches per acre : lbs*	
		1950	1951	1950	1951
1947	28.1	—	105	—	455
1946	56.6	—	155	—	943
1945	7.4	217	179	817	1,089
1944	11.3	448	440	3,173	5,262
1941	86.8	293	208	5,865	5,274
1940	57.0	364	220	8,172	6,664
1939	38.9	305	176	8,422	6,235

It will be noted that the 1947 plantings have been brought into bearing at four years old (an area planted in 1947 being reckoned as four years old during 1951). In 1950, 20.4 acres of the 1939 areas were harvested for only eight months of the year.

Research

Agronomy Division

Individual tree harvesting was continued in the very considerable number of agronomic experiments already laid down. The presentation and analysis of results has fallen seriously behind-hand owing to lack of staff. Arrangements were, however, made to send all harvest records to the Statistics Department, Lagos, where annual tree, plot, block and treatment totals can be computed by machine. In this way it is hoped that results will be brought up to date by the end of 1952.

Owing to labour shortage, maintenance of many of the Agronomy experiments was not satisfactory during the first half of the year; and in some cases manurial programmes fell behind schedule. During the latter half of the year, however, the fields were well maintained.

The seed germination campaign started as usual in August in the water-heated germinator. The final germination percentage in the 1950 campaign was sixty-eight, but germination in 1951, after a fair start, was very poor indeed. The germination percentage figures are given below :

Months from sowing	1950-51	1951-52
3	14%	15%
6	62%	37%
9	68%	39%

The reason for this very low percentage germination in 1951-52 is not understood, but this experience emphasises the need for fundamental research on germination for which a Research Officer has been specially recruited.

The tabulation and analysis of this officer's first experiments have not yet been completed though it has been shown that :

(*a*) seed may lie dormant for as long as thirty-two months without loss of viability ;

(*b*) the inner nuts from a bunch give a higher percentage germination than nuts from the outer fruits.

Interesting results are still being obtained from an experiment laid down in 1940 to test the effect of intercropping and of different covers on yield. After eight years harvesting, the plots which were intercropped are still giving the highest yield while the cutlassing of a bush cover only once a year, as opposed to regular cutlassing to 18 inches, has been shown to reduce yield.

The following experiments were planted during the year :—

(1) At the Main Station, a field experiment was laid down to test the effect of seedling vigour and early germination on subsequent growth and yield.

(2) At the sub-station at Abak in Calabar Province, a field experiment was laid down to compare the effects on yield of burning, cultivation, intercropping and different treatments of a natural cover.

(3) At the sub-station a comprehensive manurial experiment was also laid down which included application of nitrogen, phosphorus, potash, calcium and magnesium.

(4) At Umudike an area of five acres was replanted with three types of extension work seed and without felling the old trees. It is intended to carry out an observation trial with different times and methods of removing the old stand.

(5) A further close planted experiment was started at Abak in early 1952 to test the effect of time and method of transplanting on establishment and early growth. Evidence is accumulating that very early planting before the rains is to be preferred to planting in the latter half of the rains, provided that a ball of earth is taken with the seedling when it is dug up from the nursery. With the latter technique very early planting is absolutely safe.

Plant Breeding Division

The 1949-50 and 1950-51 breeding programmes were almost completed and the seeds produced are to be used in extensive plantings to be carried out in 1952 and 1953. Certain crosses which have given poor germination are to be repeated. This programme is largely concerned with (*a*) tests of inheritance of a range of *dura* and *tenera* parents crossed with two forms of *pisifera*, and (*b*) a comparison of the progeny obtained from a large number of *dura* × *pisifera* crosses. The production of *tenera* progeny from the latter cross is likely to prove the most profitable line of oil palm breeding in West Africa.

The only planting undertaken by this Division during 1951 was on two small areas totalling 2½ acres where certain introduced palms were planted. Introductions during the year included *Raphia sudanica, Acanthorhiza aculeata, Hyphaene thebaica.*

The production of controlled pollinated seed for distribution was as follows :—

Station	*Cross*			
	Dura × *Dura*	*Dura* × *tenera*	*Dura* × *pisifera*	*Total*
Ogba	244,834	212,929	188,444	646,207
Ibadan	8,067	7,765	6,080	21,912
Nkwele	31,361	30,269	35,601	97,431
Aba	88,629	23,078	75,147	186,854
Ufuma	—	1,853	48,974	50,827
Umudike	24,251	22,261	21,134	67,646
... ...	397,342	298,155	375,380	1,070,877

Of these seeds 7,472 were retained for testing, 75,000 were earmarked for Sierra Leone and 50,000 for the Gold Coast. The remainder will be distributed in Nigeria.

The Plant Breeders undertook systematic re-selection work at Ufuma and at Aba and a great deal of thought was given to the use that is to be made of these selections. It has been decided that the progenies will be concentrated on an area at the Main Station and that this work will represent the beginning of wider plans to exploit selection areas throughout West Africa.

A revision was undertaken of the seed trees which are being used for the production of extension work seed at Umudike and Nkwele.

Much work was undertaken and is still in progress in connection with pollination and the setting of fruit. A correlation was found between the percentage of setting of controlled pollinated bunches and the production of male inflorescences, and this suggests that freshness of pollen is of great importance. Studies of the effect of various storage conditions on pollen viability were therefore intensified. Temperature, humidity and atmosphere composition are the factors at present being studied.

A start was made with a study of the morphology and the anatomy of the root system and the results so far obtained have been used in considering methods of applying manures.

Pathology Division

The Division was mainly concerned with a study of nursery root disease or "blast". Although cultural treatments, particularly shade and watering in the dry season, have considerably reduced the incidence of blast, the disease has not yet been conquered nor has its cause been discovered. Towards the latter part of the year attention was drawn to a species of nematode which was found to be associated with disease in the nurseries of the Cameroon Development Corporation. These eelworms were of a species new to science. Eelworms were also readily isolated from diseased seedlings at the Main Station but the species has not yet been determined. The discovery of nematodes in conjunction with blast disease may prove to be of considerable importance. A soil fumigation experiment, however, gave no conclusive results.

With the arrival of a Pathologist in November, it became possible to give attention to other diseases of the oil palm. Most attention was given to a study of nutritional diseases represented by various types of yellowing and bronzing of the leaves. Other matters which received preliminary attention were "little leaf" disease and the incidence of *Ganoderma.* The latter is the cause of the dying off of old wild palms.

Chemistry Division

In the course of a study of the variations in the oil content of fruit, special attention was given to the laboratory technique of mesocarp oil extraction. A number of methods are being compared in order to establish a sound routine which may be followed with all future work of this kind.

The Chemist also undertook soil pH determinations for the Agronomy Division in their arable crop experiments and conducted routine analyses of fertilisers.

Statistics Division

As the Statistician did not arrive until late January he only had sufficient time during the remainder of the year to take over control of yield records and meteorological records and to make a start on the analysis of accumulated experimental results.

A. G. Beattie,
Inspector-General of Agriculture

December, 1952.

Report of the Research Adviser, 1951-1952

Inspector-General of Agriculture,
Lagos.

Introduction

As this is the first report on the work of the Central Research Organisation as established under the new constitution it will be opportune to briefly review the new structure and its aims.

The objective of Agricultural Research has previously been defined in a Statement of Agricultural Policy issued as Sessional Paper No. 16 of 1946, where it was stressed that "The goal is the improvement in the general standard of living of the people by inducing the proper use of the resources available".

The rapid increase in population now taking place in Nigeria of necessity entails a more intensive use of the land, but this will not be possible without the aid of a high level of technical efficiency in the production of both food crops and export crops. It is here that Science can play a fundamental role in devising enduring agricultural systems.

In a country as large and diverse as Nigeria, several quite different Agricultural systems will have to be planned to suit the varying climate, topography and soils, as well as catering to the inclinations of the people themselves. It is anticipated that the newly appointed Ministers of Agriculture and Natural Resources will shortly issue an Agricultural Policy for their respective Regions. These will show the Agricultural problems in relation to the special economic and social conditions of the people, and they can be analysed in order of importance and complexity, and a decision reached on the best method of investigation for achieving the desired objective. Research workers can play a fundamental part in helping to solve these problems ; the Agronomists by working out satisfactory systems of crop and animal husbandry most suited to the different climatic zones ; the Soil Scientists by surveying and classifying soil types best adapted to these systems ; the Agricultural Chemists by studies in the maintenance and enhancement of soil fertility ; the Plant and Animal breeders by producing better strains of crops, pasture, and livestock, and the Plant Pathologists and Entomologists by evolving improved methods of eliminating the wastage to Agricultural production caused through the depredations of pests and diseases.

Despite the small research staff in the past, the contribution already made to the welfare of agriculture in Nigeria is not inconsiderable. The work of the Chemistry section on studies of soil fertility is beginning to bear fruit, and in the Northern Region, the application of 50 lbs of superphosphate has been demonstrated to give an added return of 200 lbs of groundnut kernels per acre. At present prices, this means that the farmer can expect a fourfold return for his expenditure on fertilisers. Less spectacular results have been obtained in the Southern Regions, but the value of lime and nitrogen has been shown, and with the rising food prices, we may safely predict a wider application of artificial fertilisers which have not risen in cost to the same extent. The plant breeders too, have made their contribution by producing better yielding types of cotton and groundnuts, oil palms and cacao. Today however, the emphasis is on improving the yield of food crops, particularly rice, guineacorn, maize and legumes. More plant breeders are required for the field is a wide one and promising in results. The programme of work will be expanded as staff can be recruited. An inspection of the reports received from the research sections which follow shows no dearth of projects. The problem is to find the trained scientific staff to carry them out. The present Senior Service staffing position and that of the approved establishment under the new constitution for 1952-53 is as follows :—

	Present Staff	*Approved Establishment 1952-53*
Central Research Organisation		
Research Adviser	—	1
Principal Research Officer	—	1
Senior Specialists	3	3
Specialists	6	9
Rice Research Scheme R 471	—	2
Administrative Assistants	—	2
Northern Region		
Specialists	2	5
Empire Cotton Growing Corporation		
Specialists	3	3
Western Region		
Specialists	3	3
Cacao Soil Survey	4	4
Eastern Region		
Specialists	1	3
C.D. & W. Maize Rust Research Scheme, West Africa, R 224		
Chief Research Officer	—	1
Specialists	—	2
Total	22	39

Provision for Senior Service Staff is at present made from two sources :—

(*a*) Nigerian Central Funds ;

(*b*) Regional Development Funds.

Those paid from Nigerian Funds constitute a central group of thirteen Specialists who are stationed at Moor Plantation, Ibadan, but may be sent to Regions as necessity arises. During the period under review, four Specialists from the Central Research Organisation were so posted, three to the Northern Region (two Botanists and one Chemist) and one to the Western Region (Chemist).

Specialists paid from Regional Funds are normally posted to the Regions which pay their salary. They may however be required to control or undertake work in other regions, as in the case of the present maize breeder.

Provision under Regional Development Plans for Senior Service staff is as follows :—

	1951-52	1952-53	1953-54	1954-55	1955-56
North	4	5	6	7	7
West	3	3	4	4	4
East	2	3	3	4	4
	9	11	13	15	15

The total number of scientists at present holding substantive posts paid from Nigerian and Development Funds is nineteen, and the number of vacancies for the coming year amounts to seventeen. There are slight signs of improvement in the staffing situation with the promise of a Soil Scientist, Pasture Research Officer and two members of the Maize Rust Research Team due in the Autumn of 1952, and two Plant Breeders in 1953. The latter are especially needed, but there is also a great field for Agricultural Statisticians to deal with problems of crop production, land utilisation and agricultural development in general.

Co-ordination of the Research Programme

The Research Adviser is responsible to the Inspector-General of Agriculture for the direction and co-ordination of the research work. To enable him to devote the whole of his time to research matters, he will be assisted by a Principal Research Officer and provision has been made for Administrative Assistants to deal with routine matters.

The Central Research Organisation headquarters are located at Moor Plantation, Ibadan, where there are Botany, Chemistry and Entomology laboratories, a Plant Quarantine Station, Maize Rust Research Team headquarters and Central Records and Statistics.

The Cacao Soil Survey also have their headquarters at Moor Plantation and share the Chemistry laboratory facilities.

The Northern Regional Research Station at Samaru, near Zaria, has Botany, Chemistry and Entomology laboratories, and the Eastern Regional Research Station at Umudike near Umuahia, has Botany and Chemistry laboratories under construction. There is an Agricultural School at each Regional Research Station, so that Research and Training flourish side by side.

A site for the Nigerian Rice Research Station has been selected at Badeggi, near Bida, and it is planned to make a start with the building programme this year.

At each research station, a local Cropping Committee assists the Research Adviser in the direction, planning and co-ordination of the research programme. In addition a considerable amount of research is carried out in the various experiment stations located in the different crop zones in each Region.

Close contact is also kept with the Commodity Research Stations, the West African Institute for Oil Palm Research and the West African Cacao Research Institute, as well as the Agricultural Department of the University College, Ibadan, and a free exchange of information on research programmes and progress is maintained. Liaison with neighbouring territories is effected through the Secretary, West African Agriculture and Forestry Research Organisation.

Cocoa Soil Survey

Systematic mapping of soils has now been started for the first time in Nigeria by the cocoa soil survey. Its purpose is to make a soil survey of the cocoa areas of the Western Region in order to determine which portions of them are respectively most suitable for :—

(*a*) establishing with cocoa ;

(*b*) replanting with cocoa ;

(*c*) establishment of alternative crops.

The organisation came into being early in 1951, and is steadily expanding. At present, its programme of work is limited to the Western Region. This is because of the need to train and closely supervise a large number of staff in order to cover the vast areas concerned at an appreciable rate whilst at the same time maintaining a high standard of work. It is planned to extend this survey to the other Regions in about 1954 or 1955 when an experienced staff has been built up.

The main achievement of the past twelve months has been the training of the staff who are now doing very good work. The present Senior Chemist of the Central Research Organisation is the Officer-in-charge. Three other Soil Scientists have been recruited (one being temporary) and Junior Staff number about forty.

Approximately 700 square miles in the south-east of Ibadan Province have been covered by the survey. A detailed knowledge of all the soils of this area has been obtained, together with a fairly accurate estimate of the amount of land suitable for cocoa and for alternative crops. This is now being assembled togeher with maps in the form of a report for publication. Further semi-detailed surveys are now being carried out in selected parts of the "area of mass infection" of the swollen shoot disease of cocoa previously covered by the reconnaissance survey.

In addition, a "semi-detailed" soil survey of the 21 square miles of land of the Ijebu-Igbo Project of the Western Regional Production and Development Board has been made, and the soil boundaries plotted on a map at a scale of 4 inches to the mile as a basis for the cropping programme of the project.

Work in the cocoa belt, which covers some 18,000 square miles, continues.

The work of the soil survey will be invaluable in planning the orderly development of land use. It will also facilitate devising future investigations on the use of fertilisers because it will enable experiments to be sited that the results obtained will be applicable to extensive areas. It will also enhance the value of experiments which have already been completed by delimiting the area to which the result of any individual experiment can be applied.

Soil Chemistry

Work on the fertiliser requirements of groundnuts continued in the North, where an interesting sulphur deficiency was demonstrated. This investigation was stimulated by the discovery that single superphosphate was the most efficient form to apply to groundnuts, especially for haulm production, and its superiority had previously been shown to be due to its gypsum content.

The work of the Agricultural Chemist, Ibadan, included fertiliser experiments on yams, maize, rice, cotton and cassava.

Preliminary results show that early maize at Agege responded to applications of phosphate as did late maize in the Ipokia area of Abeokuta. Our existing knowledge of the responses of crops to fertilisers suggests that except in special circumstances, commercial applications may be uneconomic in the Forest Zone of the Western Region. Spectacular results however may be obtained in the Derived Savannah Zone by the use of Nitrogenous fertilisers following the clearing of the land. There may also prove to be a case for the use of artificial fertilisers in areas where fertility has been depleted by over-dense populations. Further experimental work in such areas is to be undertaken.

Studies on the exchangeable bases in soils of the Benin acid sands type by Dr H. Vine and Mr J. M. L. Kowal indicate that the calcium : potash ratio is important, as well as the amount of potash where the nutritional needs of the oil palm are concerned.

Improvement of Food and Cash Crops

Plant breeding in Nigeria received a stimulus from the visit of Dr O. J. Webster, Agronomist attached to the Economic Co-operation Administration, who carried out an extensive programme of work on guineacorn at Samaru and on maize at Ibadan. Crops studied by the Botanist, Samaru, included groundnuts, soya beans and rice. Cotton work continued under the direction of a team of botanists kindly provided by the Empire Cotton Growing Corporation.

In the South, botanical work was carried out with particular reference to maize, cowpeas, yams, and cassava, as well as cacao and citrus.

In the case of maize, a search is being made for varieties which will give a high yield while withstanding attack of the rust disease due to *Puccinia polysora*. No maize so far met in Nigerian farms shows any resistance to this rust which has caused heavy loss since 1950, and introductions of maize have accordingly been made by the Central Research Organisation from several different countries in the hope of finding a factor for resistance amongst them. The rust attack on the experimental plots in 1951 was not very heavy however so that the trials gave an indication of the potential yield of the varieties rather than of their resistance to disease. Several introduced varieties outyielded the local types and it seems likely that improvement in yield can readily be effected. No variety showed outstanding resistance under the prevailing conditions and a wider collection of varieties from many countries is being sought.

In a trial of cowpea varieties, the best results were given by some early-maturing introduced kinds. As the conditions of the experiment, late planting and an early onset of drought, favoured these quick-maturing varieties, the trial is being repeated under more normal conditions before any kind is recommended for planting in the Western Provinces.

Although sour orange has hitherto given satisfactory results in this Region as a rootstock for budded sweet oranges, a search is being made for a good alternative in anticipation of the possible introduction of the virus disease "Tristeza" which has caused serious damage in other parts of Africa, notably the Gold Coast and South Africa as well as in South America where sour orange was the common root stock. Amongst alternative stocks being tried are the tangelo hybrids, Sampson and Lake, as well as the Mandarin variety Cleopatra.

Other work on citrus has included the test of introduced lemon varieties for juice production. All samples have maintained over a period of two years the high citric acid content demanded by the trade in the United Kingdom, and it is clear from these investigations that Nigeria can produce good quality lemon juice acceptable to commercial firms. The work on varieties of sweet oranges for local use and as a source of juice concentrate continues.

There was a heavy demand for citrus bud-wood of pedigreed varieties for use in rehabilitation work in cocoa areas devastated by swollen shoot and in schemes managed by the Western Regional Production Development Board. This was supplied from the best progenies which had been yield recorded for a period of eighteen years. .

In Botanical work on cocoa, special interest is being taken in hybrids between Nigerian and Trinidadian cocoa, which are producing high yields of beans at an early age. A report from the trade has indicated the satisfactory quality of this cocoa and its suitability as planting material is being investigated.

The Control of Plant Diseases and Pests

Numerous consignments of valuable new introductions of both seeds and planting material were received at the Plant Quarantine Station, Ibadan, maintained by the Central Research Organisation. These were carefully inspected for diseases and pests, and in some instances, were grown in a quarantine nursery before being released to the Regions. Introductions of special interest included, new improved varieties of oil palm, rubber, cocoa, sugar-cane, pineapples, maize, beans, and various fodder grasses.

The control of Black Pod disease of cocoa caused by *Phytophthora palmivora* continued to engage the whole time services of a Plant Pathologist. As a result of these investigations, two methods of control are now recommended (*i*) inspection of all trees on alternate days for the removal of infected pods as soon as the first symptoms of disease appear ; (*ii*) applications of a 1 per cent Carbide-Bordeaux mixture spray at intervals of three weeks.

Losses due to Black Pod at Owena amounted to at least 50 per cent on untreated plots, compared with a loss of 10 per cent on the sprayed trees. It was found that the pods affected with disease on the sprayed plots were mainly those which were at such a distance from the ground that fungicide was not effectively applied with the hand pumps employed.

Large scale experiments on the control of black-pod disease are being carried out on a group of cacao farms near Aponmu in Ondo Province. These farms have been generously loaned by members of the Aponmu-Akure Co-operative Society. This group of farms comprises an area of about 60 acres, which is divided into portions for observations on control by spraying and by removal of infected pods respectively. There is also an untreated area for comparison.

A detailed account is kept of expenditure in connection with these experiments, so that the cost of large scale control measures can be assessed at the end of the season together with information on the numbers of healthy and diseased pods in the areas subjected to different treatments.

A serious epidemic of red rot disease of sugar-cane caused by the fungus *Colletotrichum falcatum*, appeared in the Northern Region towards the end of the rainy season in 1951. Prompt action was taken by the Central Research Organisation in arranging the importation of new disease resistant varieties of canes from the leading sugar-cane breeding stations in Africa, India, and the West Indies. An indent has been placed for an additional Plant Pathologist to study control measures against the disease.

Two serious pest control problems of cocoa, capsid bugs and stem boring beetles, also received attention from the Entomology Section of the Central Research Organisation.

Three groups of capsid bugs are responsible for a very considerable amount of damage to cocoa trees each year in the Western Region. Observations over a number of years indicate that certain areas previously free from "Capsid blast" are now subject to it, and others which have been only slightly affected in the past are being severely attacked. It would seem that one group of pests, *Sahlbergella*, is mainly responsible for the "blast" effect at least on mature plants.

A Departmental Entomologist began studies of these pests in July 1951, in continuation of work started by the West African Cacao Research Institute. This work was undertaken with the primary object of developing as quickly as possible effective and economical measures for the prevention of "Capsid blast", and of the accompanying loss of yield and even of whole groups of cocoa trees. It involved studies of the life-histories of the pests concerned, for the purpose of finding a weak spot at which control measures could be aimed, and of testing certain control methods themselves.

From 1945 onward, increasing difficulty has been encountered in establishing young cocoa under dry season conditions, owing principally to the attacks of small boring beetles. At first it was thought that one species was involved, and such chemical control measures as were tried were based on the false assumption that entry was gained only through the lower part of the stem. During the past year it has been shown that at least ten species may attack young plants and the smaller branches of older cocoa as well. Intensive studies of the life-histories of these pests are proceeding with the object of finding the weakest link in the cycle, at which to apply effective control measures. Small scale chemical control trials have also been started.

Some further work has been done on the mealybugs carriers of swollen shoot disease of cocoa. In certain areas of Ibadan Province, the numbers of one of the most efficient vectors of the disease, and its principal carrier in the Gold Coast, *Pseudococcus njalensis*, are much higher than had been reported previously. The protection afforded the mealybugs by their attendant ants is a major factor in their escaping destruction by their natural enemies. The so-called "citrus mealybug", *Pseudococcus citri*, seems at present to be the most important of those involved in transmitting swollen shoot in Nigeria. It has been observed to be attended by all the species of ants so far found in association with mealybugs within the Region, which often make fibrous shelters, or cartons for it, thus further protecting it against parasites and predators.

Maize borers have often caused heavy damage in past years, and a small experiment was begun in 1951 to determine whether a cheap and simple method of chemical control could be worked out. At the same time, observations of the moths' egg-laying rates at various seasons and stages of growth of the maize, were begun so that eventually the most effective timing of each of one or more treatments might be arrived at. So far this work has been only exploratory, but statistical field trials have been planned for 1952-53. The life-history of cotton pests studied by the Cotton Entomologist included the Red Bollworm, *Diparopsis perditor*, the Pink Bollworm, *Platyedra gossypiella*, and stainers, *Dysdercus superstitiosus* and *Campylomma sp.*

C.D. & W. Research Schemes

There are two Research Schemes which come under the administrative control of the Research Adviser, No. R 224 is for a Nigerian Rice Research station and No. R 471 is for a joint West African Research scheme to combat the new rust disease of maize, *Puccinia polysora*.

Rice Research

It is proposed to create a Central Rice Research station at Badeggi, Niger Province which will work closely in collaboration with the Rice Research Station at Rokupr in Sierra Leone. A site has been selected and it is hoped to make a start with the building programme this coming financial year. The importance of rice to all three Regions is rapidly becoming recognised, and this Nigerian Research Station should contribute much to improvement of the crop over the next few years.

Maize Rust Research, West Africa

The C.D. & W. Scheme No. R 471 provides for research into the control of the rust disease of maize caused by a fungus parasite, *Puccinia polysora* which became epidemic on maize throughout West Africa in 1950, causing losses of grain in some regions up to 50 per cent of the crop.

The pathogen is a species new to West Africa and little is known about it in scientific circles.

One of the main lines of research will be breeding new strains of maize which will be rust resistant as well as possessing other satisfactory characters such as yield and palatability. The work is to be undertaken by a team of Specialists, consisting of a Chief Research Officer, a Maize Breeder and a Mycologist, and the scheme will be administered by the Central Research Organisation which has provided laboratory accommodation for use as headquarters for the team at Moor Plantation, Ibadan. It is hoped to recruit staff in 1952-53.

Interchange of visits by Specialists to Neighbouring Territories

In addition to the visit of Dr O. J. Webster from the United States of America to advise on sorghum and maize breeding, two other specialists paid visits to Nigeria in November 1951 ; Mr J. Bowden, Entomologist from the Gold Coast came to advise on control measures against stem borers of gramineae and M. Bachy, Plant Pathologist of the Institut de Recherches pour les Huiles et Olagineux, Moyen Congo, to discuss palm diseases.

Tours made by Nigerian Specialists to neighbouring West African territories included the following :—visits to the West African Cacao Research Institute, Tafo, Gold Coast by Mr J. R. G. Sutherland, Senior Entomologist, in April 1951, to discuss control measures against cacao pests ; and by Dr J. M. Waterston, Acting Research Adviser and Mr C. A. Thorold, Plant Pathologist in October 1951 to discuss control measures against cacao diseases in Nigeria.

The Acting Research Adviser also visited the Gold Coast in June 1951, to study virus diseases of citrus and rust disease of maize, and in October 1951, at the request of the Gold Coast Government he investigated a disease of coconuts in the Keta peninsula.

Mr C. A. Thorold, Plant Pathologist, visited Fernando Po in August 1951, to observe the control measures employed on the Island against Black Pod disease of cacao and these are now being tested in Nigeria.

Mr J. T. Davey, Entomologist, visited the French Soudan in November 1951, on secondment for seven months to C.I.P.P.A.S., the International Committee for Control of the African Migratory Locust, to lead a mission making research studies on the locust within the outbreak area. The results of these observations will be of great importance in devising control measures to the whole of West Africa.

Acknowledgements

Grateful acknowledgement is made for assistance rendered by the various Commonwealth Agricultural Bureaux, particularly the Mycological Institute and the Institute of Entomology for the identification of fungi and insects causing losses to crops and stored products, and to the Secretary for Agriculture and Forestry Research, West African Inter-territorial Secretariat, for his aid on many occasions in connection with agricultural problems in Nigeria.

J. M. Waterston,
Acting Research Adviser

15th August, 1952.

COCOA SOIL SURVEY

STAFF

H. Vine	*Senior Chemist and Officer in Charge*
W. G. D. Walters	*Soil Scientist*
V. J. Weston	*Soil Scientist*
R F. Montgomery	*Soil Scientist*

INTRODUCTION—H. VINE

In March 1951, work was begun on a programme of systematic surveys of the soils of the cocoa belt of the Western Region. The need for this work arises from the fact that in the main cocoa-producing districts a great deal of the existing cocoa will soon be over the age of twenty-five to thirty years, which is commonly found to be the limit for high yields and healthy growth, whilst there is not very much land left under forest for new planting. It is becoming increasingly urgent that the soil types best suited to cocoa should be clearly recognised, new areas of these soils used to the best advantage, and replanting done on a large scale on suitable soil types.

During the last sixty years, planting of cocoa has been tried very extensively on land newly cleared from forest (well grown secondary forest or high forest), with very little conscious choice of soils. The suitability or otherwise of the various soil types for cocoa is now indicated very largely by the relative amounts of good cocoa to be found growing on each. On unsuitable soils, planting has usually failed and good plots have only become established as a result of particularly favourable weather during the first two or three years. On the other hand, on the most suitable soil types, cocoa has been grown successfully where the land was previously under forest, but has apparently not been tried very much where the land was already in use for growing of food crops at frequent intervals.

Plans for systematic soil surveys in the cocoa areas of West Africa were first drawn up by Mr C. F. Charter, then Soil Scientist at W.A.C.R.I. in 1945-46. These were based on the employment of teams of junior assistants to cover the ground rapidly and collect samples by routine methods, for classification and plotting on maps by more advanced assistants, under the supervision of a few Senior Officers. The method which Charter termed "Detailed-Reconnaissance Soil Survey" was evolved. This consists of a combination of detailed surveys of sample areas, for the purpose of defining precisely the basic units of classification, and a reconnaissance survey of the whole area being studied, by means of suitably spaced traverses ; in the reconnaissance survey the boundaries of composite mapping units (soil catenas, complexes, or associations) are plotted approximately and the relative extent of the individual soils making up each of these composite units determined by identification of the soil from profile samples collected at regular intervals and counting up the number of points at which each soil is found.

The writer was seconded to the Gold Coast in 1948, and worked under Mr Charter on the Detailed-Reconnaissance Soil Survey of the Ayensu Basin, in which the method was put into operation completely and Soil Series and Soil Associations defined for the first time in an extensive survey. The experience gained made it possible to undertake similar work in Nigeria. An organisation for this work had already been planned with the advice of W.A.C.R.I. and funds had been allocated by the Cocoa Marketing Board.

METHODS

The programme of work is to carry out two main types of survey-reconnaissance surveys to cover the whole cocoa belt, section by section (a total of about 18,000 square miles in the Western Region), and semi-detailed surveys of special areas (about 1 or 2 to 50 square miles in extent).

RECONNAISSANCE SURVEYS.

In these surveys, parallel traverse lines are being laid out 4 miles apart, profile samples collected from chisel holes and auger borings to a depth of 2½ to 4 feet at intervals of 220 yards along the traverses for classification, and the vegetation or land use recorded at each sampling point. Heights above sea-level are being recorded from corrected aneroid barometer readings along the traverses also, which will be available for plotting of form lines from air photographs in future.

A small number of detailed surveys of sample strips are being done in the course of the reconnaissance surveys, to assist in working out the basic mapping units. Special profile pits are dug in each soil mapped in these detailed surveys.

The reconnaissance surveys have two main purposes—(*i*) to enable the soils to be classified, defined, and described, and their potentialities assessed, as a basis for carrying out semi-detailed surveys, and (*ii*) to produce small-scale maps (1 to 125,000 or 1 to 250,000) showing the approximate distribution of the recognisable soil associations or catenas and to give an estimate of the relative extent of each individual soil. Incidentally, a record is made of the present usage of each soil.

Semi-detailed Surveys.

In these surveys, traverse lines being made 220 yards apart and samples collected from chisel holes 110 yards apart along the traverses (one hole to 5 acres). Barometer readings are taken at the same points and used for compiling a contour map with form lines at 20 feet vertical intervals; in order to do this, it is also necessary to draw a plan of the drainage, which is done by sending Assistants to follow the course of each stream encountered and record the points where it crosses any of the traverse lines.

From these data, semi-detailed soil maps on the scale 4 inches to 1 mile are drawn, showing the approximate boundaries between the main soils. It is not possible to draw these boundaries from the soil records alone, without having a much greater number of holes recorded. The procedure is to place a copy of the contour map, drawn on tracing paper, on top of a plan showing the soil recorded at each chisel hole, and then to sketch in the soil boundaries to conform with the topography. This is necessitated by the dense vegetation covering nearly the whole of the area of the cocoa belt, which makes it impossible to observe the "lie of the land" and to sketch in the soil boundaries accordingly in the field.

The semi-detailed soil maps are intended to be the basis for planned use of land, and particularly as a direct guide for planting of cocoa. The scale of 4 inches to 1 mile (1 square inch to 40 acres) is suitable for drawing up cropping plans, using blocks and fields of the sizes required in practice. The boundaries shown are not meant to be completely accurate, and the areas of any soil, as shown on the map, actually include small amounts of other soils. A completely accurate map of soil boundaries would be too complicated to be of direct use, and any greater detail than is shown on these semi-detailed maps would have to be ignored in practice.

AREAS SURVEYED

The field work of two main surveys carried out by the methods described above was nearly completed by the end of March 1952 (both were actually finished in April). These were :—

(*a*) the reconnaissance soil survey of the south-eastern part of Ibadan Province, between the Omi and Shasha Rivers (approximately 750 square miles) begun in March 1951 ;

(*b*) a semi-detailed soil survey of the Ijebu Plantations Project of the Western Regional Production Development Board (21 square miles) began in November 1951.

The Ijebu Plantations Project is situated south of the Omi-Shasha area, and the soils found there are the same as those of the greater part of this area, so that the classification which was being evolved during the early part of the year in the reconnaissance soil survey of the large area was applicable to the semi-detailed survey also. The final classification was based on both surveys.

All pieces of land in the neighbourhood of Asejire (which is in the middle of the Omi-Shasha area) which were proposed for planting of tree crops by the Production Board, for local co-operative groups, were examined, and advice given as to their suitability for citrus or oil palms. A reconnaissance survey of an area of about 200 acres between Awa and Asigidi villages, near Ijebu Igbo, where a minor development project was proposed, was also carried out.

Descriptions of the two main areas surveyed, with soil maps and a detailed account of the soils, will be published as soon as possible. In the case of the survey of the Ijebu Plantations Project, a map has been produced, since the completion of the field work, showing the areas recommended for the various crops, and the planting programme for 1952 was based on the results of the survey, particularly in the choice of land for cocoa and for citrus ; the contour map produced by the Soil Survey is also being used already for planning the road system and general development.

SOIL CLASSIFICATION

The chief problem in all this work is the classification of the soils into mapping units. The main units employed in such surveys, particularly by soil surveyors in the U.S.A. and in England and Wales, are termed Soil Series, and the soil series has been adopted as the basic unit in the Gold Coast and now also in Nigeria.

A provisional classification of the soils of the Omi-Shasha area into soil series was drawn up at the beginning of the year. Similar soils to those of the greater part of the Ayensu Basin in the Gold Coast were recognised, and the division into series was on similar lines to those followed in the work there, with some modifications. Different series names were introduced, however, because the definitions of series being mapped in the Gold Coast were still subject to revision.

In the provisional classification into series, the following four factors were taken into account (in order given here) :—

(1) Drainage : (soils divided into (*a*) well-drained and fairly well-drained, (*b*) poorly drained, and (*c*) seasonally flooded or swampy).

(2) Type of parent material, as regards mode of formation : (soils divided into :—

(*i*) "Eluvial mottled Earths with a thick mottled clayey layer formed by decomposition of the bed-rock in place ;

(*ii*) Soils formed from hill-creep material, lacking the thick clayey layer formed in place ;

(*iii*) Skeletal soils ;

(*iv*) Soil formed from hill-wash material or local alluvium, and

(*v*) those formed from stream or river alluvium).

(3) Colour and mechanical composition.

(4) The predominant type amongst the underlying rocks.

Drainage and mode of origin were put first, on the principle that a soil series should be as far as possible a recognisable feature of the landscape or should consist of a distinct part of the catena (topographical sequence) of soils, and because, if an attempt were made to define soil series too rigidly on the basis of the characteristics of profile pits, rather than as features of the landscape, plotting of boundaries would be very difficult and the map would tend to become a mosaic of small patches of different kinds of soil. However, mode of origin has actually to be judged mainly from the profile features—the mechanical composition, the depth of gravel layers, and signs of boulders or bed-rock.

The division into series was revised and extended during the first few months of the reconnaissance survey, when fairly detailed surveys of four sample strips (measuring 1 mile by $\frac{1}{4}$ mile) were also done. It was then considered necessary to record more definitely what variations occurred in each series being mapped, and also to recognise any sub-divisions of soil series which could usefully be mapped separately on any practical scale. In order to carry out this detailed study, in the later part of the year the technique was adopted of laying out the profile samples collected from chisel holes and auger borings along the traverses in receptacles made by splitting bamboo stems into halves, so that the profiles could readily be sorted, compared, and rearranged according to any variations which were noticed ; large numbers of profiles were stored for some time on racks in this way to enable checking and reclassification to be done if required. Further information was gained from the study of profile pits about six feet deep, but the general conclusion was reached that the soils being investigated could be most satisfactorily classified if attention were concentrated on the top 2 or 3 feet of the profile, which is also the most significant part of the soil from the practical point of view.

In the American system, many soil series are divided into two or more textural "types", which are often further divided into "phases" (particularly on the basis of depth, stoniness, degree of slope, and minor variations in drainage), and these would form the mapping units in surveys on the scale of the semi-detailed surveys being done in Nigeria. In most of the important series set up in the present work, two or more fairly distinct variations have been recognised and the profiles classified and plotted accordingly on the maps. The possibility of mapping these variations separately as "sub-series" was investigated, particularly in a sample strip of half a square mile, which had simpler terrain and less mixed rocks than much of the land being surveyed ; it was found that a scale of about 16 inches to 1 mile (four times that of the semi-detailed surveys) and sampling at intervals of 22 yards along traverses 44 yards apart would be required for mapping any sub-divisions of the soil series.

In the final classification of the soils into series, given below, the division into three drainage classes has been adhered to closely. Within each of these classes the soils have, on the whole, been satisfactorily sub-divided on the basis of colour, mechanical composition, depth of gravel layers, and presence or absence of boulders or signs of decomposed rock *in situ* (thus taking mode of origin into account, as intended). Further sub-division on the basis of type of parent rock has been rather arbitrary in the case of the clayey-textured brownish to reddish soils formed *in situ* from schists and gneisses ; there is no clear boundary separating the schists from the gneisses, and the two series (regarded as being formed from gneisses) is therefore not definitely distinguishable from the Egbeda series or intermediate soils between Egbeda and Olorunda series (characteristically formed from schists). Another rather arbitrary step has been to omit any separate series in which to classify the profiles having a shallow sandy or clayey soil overlying a hard layer of concretions, which are found associated with normal soils of the Egbeda, Olorunda, Iwo, and Ibadan Series, and occurring typically in a narrow zone on the upper part of the slope. These have been recorded as concretionary variations of those series, although it was originally intended to classify them together as Gambari Series. Apart from these two cases of particular difficulty in classification, there are inevitably large numbers of profiles which are transitional or intermediate between two series ; soils which are intermediate between Apomu Series and Ibadan, Iwo, or Asejire Series are common, as also are soils which are intermediate between Egbeda Series and Olorunda Series.

The final classification worked out for the soils of the Omi-Shasha area and the Ijebu Plantations Project is as follows :—

CLASSIFICATION OF SOILS OF OMI-SHASHA AREA (IBADAN PROVINCE) AND IJEBU PLANTATIONS PROJECT

I.—Well Drained Soils

A.—Formed from Residual Material

(1) *Egbeda Series.*—Reddish-coloured clayey soils on upper slopes in the typical rolling topography ; derived mainly from biotite schist.

Egbeda Series (Normal Variation).—The typical profile has the following layers :—

0-2 inches. Dark greyish-brown humic very clayey fine sand (formed from worm-casts).

2-6 inches. Greyish-brown very clayey sand.

6-15 inches. Brown rather loose very clayey sand with frequent quartz gravel and rather few concretions.

15-30. Reddish-brown very clayey sand to sandy clay with quartz gravel and concretions as above.

30-48 inches. Brownish-red fine-sandy clay with a few pieces of quartz gravel ; easily crumbled.

Below 48 inches. Orange-brown clay with bright red mottling formed by residual pieces of decomposed schist, and some pale yellowish mottling ; less easily dug or crumbled than the layers above.

Egbeda Series (Sandy Variation).—Loose consistence and sandy texture to about 15-27 inches.
Egbeda Series (Very Red Variation).—Browner very clayey sand top-soil to about 6 inches, and redder fine-sandy clay sub-soil ; less yellowish mottling below.
Egbeda Series (Rotten Rock Variation).—Occasional patches of Egbeda Series in which a fair amount of red decomposed schist is found not far from the surface (at about 30 inches).
Egbeda Series (Mottled Variation).—Occasional patches where the more compact mottled clay usually found below 48 inches is within about 24-30 inches from the surface.
Egbeda Series (Very Concretionary Variation).—Brownish sandy soil with frequent concretions 12 to 24 inches deep over a layer of broken-up concretionary ironstone or a very large quantity of concretions.

(2) *Olorunda Series.*—Clayey soils with a similar profile to that of the Egbeda Series and generally occurring in very similar sites ; differing from the Egbeda Series in two ways :—

(*a*) The colour is paler ; top-soil grey to pale brown to brown, and sub-soil brownish yellow to pale brown to pale reddish brown ;

(*b*) The mottled clay layer is very frequently found at depths of about 27-36 inches : this layer is somewhat compact and less favourable to root penetration than the sub-soil of the Egbeda Series.

Olorunda Series (Normal Variation).—Pale brown to pale reddish brown sub-soil ; mottling more than 36 inches from surface.
Olorunda Series (Shallow Mottled Variation).—Same colour range as Normal soils ; mottling at less than 30 inches from the surface.
Olorunda Series (Sandy Variation).—Loose consistence and sandy texture to about 15-27 inches ; often very gravelly.
Olorunda Series (Very Pale Variation).—Yellowish-brown sub-soil ; mottling more than 36 inches from surface.
Olorunda Series (Very Concretionary Variation).—Similar to Egbeda Series (Very Concretionary) but associated with other soils of Olorunda Series ; generally a greyish colour.

(3) *Iwo Series.*—Similar to Egbeda Series (Normal and Sandy Variations), but generally duller in colour and rather sandy ; decomposed gneiss or granitic bands often found in profile pits at a depth of about 6 feet.

(4) *Ibadan Series.*—More sandy and gravelly than Iwo Series. Grey-brown clayey sand top-soil over loose brown clayey sand sub-soil containing quartz gravel and some concretions, to about 30 inches depth, over reddish sandy clay merging into a mottled layer with some decomposed gneiss or granitic bands.

(5) *Ife Series.*—Excessively gravelly soil. Grey-brown clayey sand top-soil over pale grey-brown gravel sub-soil (containing very little sand and clay) to a depth of about 30 inches, where it overlies a reddish or brownish sandy clay layer, which emerges into mottled clay and rotten rock (largely consisting of decomposing pegmatite).

(6) *Shanroji Series.*—Only found in sufficient amounts to form a Series along the Southern boundary of the Ago-Owu Forest Reserve. Pale greyish-brown sandy soil with some gravel to depth of 18 to 30 inches, over pale brown and reddish-brown mottled sandy clay (a truncated Elluvial Mottled Earth profile).

(7) *Odeyinka Series.*—Found only in occasional chisel holes. Grey top-soil over pale greyish-brown very clayey coarse sand with much quartz gravel and few concretions, very sticky when wet, over pale reddish coarse sandy clay with gravel.

(8) *Odeomu Series.*—Found in the north-east corner of the Omi-Shasha area, but known to be extensive in Savannah areas over granite rocks further North and West. Shallow grey to brown sandy soil with loose concretions, over broken-up concretionary ironstone hardpan, covering the hilltops in rolling or undulating country.

B.—Formed from Hill-Creep Material

(1) *Asejire Series.*—Sandy and gravelly soils, over granitic rocks and gneisses, less deeply weathered than Ibadan Series.
Asejire Series (Normal Variation).—Clayey sand top-soil over a loose brown clayey sand layer with quartz gravel and stones to a depth varying from 15 to 45 inches, which may contain some concretions, overlying mixed gritty clay and rotting granitic rock.

Asejire Series (Reddish Variation).—Gravelly hill-creep material becomes reddish and more clayey from about 20 to 36 inches depth ; mixed gritty clay and rotting granitic rock occur at about 36 to 45 inches.

Asejire Series (Pale Variation).—Pale brown to greyish-yellow colour ; pieces of granitic gneiss or pegmatite often present.

(2) *Akure Series.*—Brownish clayey sand to sandy clay to about 15 inches, merging into red sandy clay which extends to a depth of 5 feet or more ; occurring on moderate slopes, with outcrops of granite or gneiss higher up.

(3) *Balogun Series.*—Similar to Asejire Series, but more clayey, or similar to Akure Series but brown in colour and less clayey.

(4) *Araromi Series.*—Brown very clayey sand to sandy clay of friable consistence, usually with some gravel, stones, and rock fragments, derived from hornblende gneiss or diorite which may be mixed with other rocks.

C.—Skeletal Soil

Ekiti Series.—Brownish-black humic clayey sand with gravel and rock fragments, about 6 to 24 inches deep, over hard granite or gneiss, on hills.

D.—Formed from Hill-Wash and Local Alluvium

(1) *Apomu Series.*—Sandy soil with very little gravel or none, at least 18 inches deep and usually about 30-60 inches deep ; generally occurring on the lower slopes of hills or undulations, but also not infrequently on upper slopes and occasionally even on nearly flat ground at the top of the slope.

Apomu Series (Normal Variation).—Pale brown in colour, with brownish-grey top-soil.

Apomu Series (Reddish Variation).—Reddish-brown colour below about 18 inches.

Apomu Series (Very Pale Variation).—Very pale brownish colour, but not the pale yellow or grey washed-out appearance of Matako Series.

Apomu Series (Very Concretionary Variation).—Occasional patches occurring in Apomu Series having a large quantity of knobbly brown concretions at about 15 inches, mixed with pale brown slightly clayey sand.

(2) *Iregun Series.*—More clayey than Apomu Series ; non-gravelly to at least 18 inches depth ; occurring on slopes.

Iregun Series (Normal Variation).—Grey-brown clayey sand top-soil over pale brown to greyish-yellow very clayey sand to sandy clay to a depth of about 24-48 inches, overlying dull-coloured mottled sandy clay.

Iregun Series (Orange Variation).—Pale brown or brown very clayey sand merging into orange-brown very clayey sand to sandy clay below about 18 inches.

Iregun Series (Reddish Variation).—Reddish-brown to red colour below about 18 inches.

(3) *Mokore Series.*—Brownish-grey very clayey fine sand to sandy clay, usually containing frequent round brown and black concretions at a depth of about 2 feet, on lower slopes, associated with Araromi Series on the upper slopes.

II.—Poorly Drained Soils

(1) *Matako Series.*—Grey sandy top-soil over very pale yellowish or greyish sand or silty sand a few feet deep, usually with some brown spots or soft concretions below about 12-18 inches. Very wet after heavy rains, but dries out to a depth of several feet in the dry season.

(2) *Jago Series.*—Clayey sand to depth of 24-48 inches or more ; mottling generally found at about 15 inches.

(3) *Adio Series.*—Very clayey sand to sandy clay to depth of 24-48 inches or more with brown mottling below about 12 inches.

(4) *Shasha Series.*—Grey to brown fine sandy top-soil about 3 inches deep over pale brown sand 2 to 6 feet deep, over brownish mottled sandy-layers ; occurring only along rivers and large streams, typically forming levees a few yards to a few chains wide.

(5) *Majeroku Series.*—Brownish-grey slightly clayey sand about 18-30 inches deep, usually with some brown mottling in the lower part of this layer, and typically having gravel and water-worn stones at the base, over stiff and impervious mottled clay which merges at a depth of a few feet into a mixture of clay and rotten rock ; found mainly on sloping ground about 25 to 50 feet above the Oshun, Shasha and Omi Rivers.

III.—Swampy and Seasonally-flooded Soils

(1) *Ikire Series.*—Thin dark-grey or grey-black humic silty sand top-soil over grey sand or clayey sand layers with brownish mottling or rusty root channels, at least 15 inches deep. sometimes having sandy clay below that depth ; generally mottled clayey decomposed rock is found at a depth of about 3 to 5 feet, and gravel and stones are commonly found in the lower part of the transported material.

(2) *Oshun Series.*—Sandy clay or silty clay soil of dark or pale greyish colour, with brown mottling and rusty root channels.

SUMMARY OF SOIL SERIES

I.—WELL DRAINED SOILS

A.—Residual	(1) Egbeda Series ...	predominantly normal elluvial mottled earth profiles.
	(2) Olorunda Series ...	
	(3) Iwo Series	
	(4) Ibadan Series ...	
	(5) Ife Series	
	(6) Shanroji Series ...	truncated eluvial mottled earth profiles.
	(7) Odeyinka Series ...	pale sticky sandy soil.
	(8) Odeomu Series ...	soils with broken-up hardpan on hill-tops in rolling or undulating country.
B.—Hill-Creep	(1) Asejire Series ...	granite and gneiss areas.
	(2) Akure Series ...	
	(3) Balogun Series ...	
	(4) Araromi Series ...	hornblende gneiss and diorite areas.
C.—Skeletal	(1) Ekiti Series	
D.—Hill-Wash	(1) Apomu Series ...	very sandy.
	(2) Iregun Series ...	more clayey.
	(3) Mokore Series ...	clayey ; hornblende gneiss and diorite areas.

II.—POORLY DRAINED SOILS

(1) Matako Series ...	in depressions and valley bottoms.
(2) Jago Series ...	
(3) Adio Series ...	
(4) Shasha Series ...	river levees.
(5) Majeroku Series ...	on slopes ; soils with stiff mottled clay layer.

III.—SWAMPY AND SEASONALLY-FLOODED SOILS

(1) Ikire Series ...	sandy.
(2) Oshun Series ...	clayey.

SUITABILITY OF THE SOILS FOR COCOA

Cocoa is grown with some success on the following soil series :—Egbeda, Olorunda, Iwo, Asejire, Akure, Balogun, Araromi, Iregun, Adio and Oshun.

The Egbeda Series is the most important for cocoa in the Omi-Shasha Area and the Ijebu Plantations Project ; the redder and more clayey soils of this Series, having a loamy surface, are particularly favourable. It is suspected that phosphatic fertiliser may prove beneficial to cocoa on the Egbeda Series, but it may be more important to maintain or improve the humus content and structure of the surface soil in old cocoa farms.

The Olorunda Series is generally less satisfactory than the Egbeda Series, especially in the case of the Sandy and Shallow Mottled Variations. The Normal Variation has suitable physical properties for cocoa, but is possibly rather lacking in fertility.

The Iwo Series is variable, but includes considerable areas on which good cocoa has been established.

The Asejire includes patches having clayey sub-soils where cocoa grows well, but these are irregular and scattered.

The Akure Series is generally very suitable for cocoa, but it occurs mainly in rather limited patches; in the areas surveyed it occupies only a very small total area.

The Balogun Series, like the Akure Series, occurs in rather small patches; the suitability for cocoa depends on the clay content.

The Araromi Series consists mainly of first-class cocoa soils, and the chief area of this Series found, over several small hills near the south-east corner of the Omi-Shasha area, is covered almost solidly with exceptionally good mature cocoa. Both the physical and the chemical properties of these soils appear to be very good.

The Iregun Series is rather inferior for cocoa, but considerable amounts of cocoa are found on it.

The Adio Series occurs in irregular strips and patches in low ground, but forms a considerable area on the whole. It grows cocoa well, and the crop may be longer-lived on this Series than on the well drained soils.

The Oshun Series is generally found only in small amounts. Some areas have been recorded where the Series is more extensive and good cocoa is found, but these are probably transitional to Adio Series and not strictly swampy.

SUITABILITY OF THE SOILS FOR OIL-PALMS AND CITRUS

Oil-palms grow fairly well on practically all of these soils. There is some doubt, however, as to the profitability of plantations on some of the soils under the comparatively low rainfall of the northern part of the Omi-Shasha area (about 45 to 55 inches). Poorly drained and swampy soils, especially Jago, Adio, and Ikire Series, are therefore the most suitable.

The following Series, having free drainage and a fairly clayey sub-soil, appear to be suitable on the whole for citrus :—Egbeda, Olorunda, Iwo, Ibadan, Asejire, Akure, Balogun, Araromi.

CHEMISTRY SECTION

Chemistry Work in the North

STAFF

M. Greenwood	*Chemist (Temporary)*
G. M. Higgins	*Chemist*

As a result of two Senior Service Officers being available at Samaru and also due to the accession of new Junior Service staff it has been possible to maintain a full programme of field experiments during 1951-52; and also to resume analytical work for the North.

Mr M. Greenwood, O.B.E., Chemist (Temporary) left the section on 23rd March, 1952 on retirement.

Mr G. M. Higgins, Chemist, assumed duty on first appointment on 9th September, 1951.

SULPHUR DEFICIENCY IN GROUNDNUTS

Interaction of Sulphate with Ammonium, Calcium and Phosphate

The beneficial action of gypsum (calcium sulphate) and ammonium sulphate on groundnuts was further investigated at Samaru and Kontagora by studying the interaction of ammonium, calcium, sulphate and phosphate. Ammonium and calcium were supplied as chlorides, sulphate as sodium sulphate and phosphate as sodium dihydrogen phosphate; they were applied to the soil one to two days before sowing. The phosphate treatment was equivalent to 50 lbs single super; the other treatments were equivalent to 50 lbs gypsum per acre.

At *Kontagora* where a direct response to gypsum had been previously shown in both kernel and haulm yields, all plants receiving sulphate were noticeably bigger and greener than all others within twenty-three days; at ninety-six days their weight was double that of the rest. At harvest the increments due to sulphate were 518 lb. kernels/acre = 69 per cent of No sulphate and 1,123 lb. haulms/acre = 91 per cent of No sulphate. Both ammonium and phosphate produced increases in kernel yield of the order of 10 per cent but had no effect on haulm yield. There was significant positive interaction between ammonium and sulphate in respect of both kernels and haulms.

At *Samaru*, where gypsum had previously proved effective only in the presence of phosphate, the effect had been most pronounced on poorly drained land. The present experiment was therefore sited on low-land which became water-logged during the heavy rains of September. Yellowing in plots not receiving sulphate became apparent only at sixty-eight days, and there was no significant difference in the weights of sample plants collected at seventy-six days. Sulphate in all combinations subsequently produced plants which were larger and retained their leaves longer than plants of other treatments. At harvest the increases due to sulphate were 191 lb. kernels = 19 per cent of No sulphate and 633 lb. haulms = 46 per cent of No sulphate. Phosphate gave a 10 per cent increase in kernel yield but had no effect on haulm yield; ammonium gave a 10 per cent increase in haulm yield but had no effect on kernel yield. There was a significant positive interaction between ammonium and sulphate in respect of haulms.

Both at Kontagora and Samaru sulphate produced significant increases in

(*i*) the number of nodules per plant;

(*ii*) the area of individual leaves;

(*iii*) the nitrogen content of both leaves and kernels.

Sulphur v. Sulphates

At Kontagora and Samaru a test was made of the relative efficiencies of sulphur and gypsum dusts and of a sodium sulphate spray applied to the foliage seven weeks after sowing. Rates were equivalent to 100 lb. gypsum per acre; they were applied in the presence and absence of 20 lb. sodium dihydrogen phosphate per acre.

At *Kontagora* all sulphur treatments produced a marked darkening in foliage within twenty-one days of application. Increases in kernel yield range from 186 to 253 lb./acre (25% to 35% of No sulphur), the differences between the three treatments being insignificant.

The haulm yield was increased by 416 to 768 lb./acre (38% to 70% of No sulphur), the increases due to gypsum and sodium sulphate being significantly greater than that due to sulphur. Phosphate had no significant effect on either kernel or haulm yield.

At *Samaru* the experiment plots were equally divided between two fields. In one field response to the sulphur treatments was apparent within eighteen days of application. There were increments of 298-372 lb. kernels per acre (32% to 40% of No sulphur) and 318-618 lb haulms (29% to 55% of No sulphur). As at Kontagora there was no significant difference in the kernel increase due to the different sulphur carriers, but sodium sulphate produced an increase in haulm weight significantly greater than that due to sulphur. *Phosphate* had no significant effect on kernel yield but gave a significant increase of 134 lb. haulms/acre

In the second field no response to the sulphur treatments was apparent throughout the experiment. Foliage was normal in colour except for a slight yellowing in one plot receiving phosphate only, and the treatments produced no significant increase in either kernel or haulm yields. There was, however, a marked response to *phosphate* in this field; the increase in kernel yield was 276 lb./acre (32% of No phosphate) and 440 lb. haulms (33% of No phosphate). It is hoped that the different behaviour of these two fields will help to determine the level of available sulphur at which deficiency in groundnuts becomes apparent.

FERTILISER FOR DISTRIBUTION SCHEME

Single superphosphate rather than the more concentrated phosphatic manures had been recommended for distribution to farmers partly on account of its content of calcium sulphate (gypsum). Since the present world shortage of sulphur made it doubtful whether further supplies of single superphosphate would be obtainable it seemed advisable to experiment with phosphatic manures containing a smaller proportion of sulphur. A mixture of two parts of triple super and one part of ammonium sulphate had previously been used successfully and there were indications that its nitrogen content would make it more effective than single super with grain crops.

The mixture (containing phosphate, nitrogen and sulphate) was therefore tested with guineacorn or millet at seven major stations in comparison with equivalent rates of single superphosphate (phosphate + sulphate), monammonium phosphate (phosphate + nitrogen) and triple superphosphate (phosphate only). Rates were equivalent to 11 lb. P_2O_5 per acre; all fertilisers were used in granular form and were placed near the seed by scoops delivering a single-stand dosage. One of the main purposes of the experiment was to determine whether groundnuts would in 1952 derive a residual effect from the triple super-ammonium sulphate mixture comparable to that usually obtained from single super.

No detriment to germination due to placement of the more soluble fertilisers was reported from any of the experiment sites. The fertilisers containing nitrogen were generally found to give more rapid growth of seedlings, but the results at present available have shown :

(*i*) No significant difference has been obtained at any station between fertilisers themselves.

(*ii*) At only one station Daura, has the difference between fertiliser and non-fertiliser plots been significant. A summary of yields of grain/acre is presented below.

Station and Crop	1 *No Manure*	2 *Super*	3 *Triple*	4 *Dutch*	5 *Monamm.*
		**	**	**	**
Daura : Millet	402	713 > N.M.	619 > N.M.	690 > N.M.	650 N.M.
Kafinsoli : Guinea-corn	1,319	1,350	1,512	1,529	1,513
Bida : Guinea-corn	396	409	546	474	465
Maiduguri : Millet	752 (97)	733 (117)	780 (91)	756 (63)	858 (65)
Samaru	1,145	1,534	1,434	1,429	1,562

N.M.=No Manure. Maiduguri Figure in brackets=yield of interplanted cow peas threshed seed lb/acre.

PLACEMENT TRIALS

Exploratory trials of the response by various crops to combinations of superphosphate and sulphate of ammonia in Ilorin and Plateau Provinces have made it necessary to investigate possible methods of placement of ammonium sulphate.

A number of pot experiments have been made, and results up to date indicate that—

(1) Spot treatment allows better germination than equivalent rates ringed round the seeds.

(2) Applications of 120 lb./acre (spacing $3' \times 3'$) applied as a spot treatment reduce the germination percentage, when placed as much as 3" away.

RESIDUAL EFFECTS

Reference has been made in previous reports to the persistent residual effect of superphosphate applied to Sorghum at Kano in 1947. The effect was again tested by groundnuts in 1951, and results again show a significant residual effect due to superphosphate.

The total profit due to the application of 50 lb. of superphosphate over five years now lies at £11 12s per acre.

GINGER

Fifty-one samples covering the 1952 purchase of 34 tons 11 cwt. Grade I and 22 tons 14 cwt. Grade II in the Kachia Ginger Market were analysed at the beginning of March. All samples conformed to B.P. requirements, and there was a very slight reduction in quality as compared with a previous years' results. Average values for the three years are :—

Grade	*Year*	*Water Sol. Extract %*	*Alcohol Sol. Extract %*	*Total Ash %*	*Water Sol. Ash 1%*
I	1952	13.0	6.3	4.7	2.8
	1951	14.0	6.5	4.5	2.9
	1950	13.7	6.4	4.3	3.0
II	1952	13.4	6.5	4.5	2.8
	1951	14.0	6.7	4.6	2.9
	1950	13.9	7.1	4.6	3.0

MISCELLANEOUS

Analyses of the juices of a number of varieties of sugar-cane have been made for Principal Agricultural Officer, Samaru and Agricultural Officer, Zaria : the feeding values of hay have been determined for Samaru School and various samples of Gamba Grass cut at different times have been examined for Senior Agricultural Officer, Kano, together with groundnut tops from the same area. Examination of soils from Ilorin, Samaru, Kontagora, Maiduguri, Shendam, Shemankur, Sokoto, Mokwa, Yola and Bauchi has been carried out.

Analyses of fortified and non-fortified farm-yard manure from Ilorin have also been completed, and phosphate determinations of a number of groundnut samples have been carried out.

A field trial of ammonium trichloracetate as a control for Dhub Grass (*Cynodon dactylon*) has now entered into its second cycle, the residual effect being tested with guineacorn.

Investigations into the causes of chlorosis on neem and citrus from Maiduguri and Yola continue, and a start has been made in the Soil Survey of Samaru and the surrounding areas.

Chemistry Work in the South

STAFF

H. Vine	*Senior Chemist*
H. Irving	*Chemist*
J. M. L. Kowal	*Development Officer*
L. Heapy	*Chemist*

Dr Vine was seconded as Officer-in-charge of the Cocoa Soil Survey for the entire year. Mr H. Irving resumed duty on return from vacation leave on 23rd May, 1951. Mr L. Heapy was stationed at Ibadan for a few months prior to assuming duty as Agricultural Chemist, Umudike, in the Eastern Region.

There were two Senior Service Officers in the section throughout the year, and with a small increase in Junior Service staff a full programme of work was maintained.

FERTILISER EXPERIMENTS—H. Irving

Fertiliser experiments were laid down on various crops, yams, maize, rice, cotton and cassava in both Eastern and Western Regions. The Agricultural Chemist visited these experiments several times during the growing season. The statistical results of the experiments are given in Project Reports.

A.—Western Region

Rice.—Two replications of 3^3 factorial experiment using N, P and K were laid down at Ifaw in Abeokuta Province. Unfortunately the experiment was ruined by termite activity.

Early Maize.—One experiment was laid down on the Poultry Section of Agege Experimental Farm. The experiment is based on a 4-year cycle and is therefore replicated four times. Preliminary results show that phosphate application increases yields.

Late Maize.—The late maize in the Agege Experiment had fertiliser treatments. In Ipokia area of Abeokuta Province three macro and two micro experiments were laid down with N, P and K. Results vary somewhat but phosphate response predominates and in several cases there is a definite Nitrogen-phosphate positive interaction. A series of observation trials on the time of application of Sulphate of Ammonia to late maize were set out of farmers' crops with varied results.

Yams.—Two experiments were laid down on yams in both Ondo and Oyo Provinces. The statistical results of these experiments are yet to be completed.

Tobacco.—In co-operation with the Nigerian Tobacco Company, fertiliser and variety experiments were set out on flue-cured tobacco at Ago Are. The results of the variety trial were highly significant not only in total quantity of tobacco but in percentage "Brights". Responses to fertilisers were apparent but did no prove significant due in all probability to insufficient replications. Future work will ensure a larger number of replications.

B.—Eastern Region

Yams and Intercrops.—Factorial N P K experiments (a total of nine) were laid down on yams, which were cropped according to local practice, in all provinces except the Cameroons. The harvest results are being statistically analysed at the present time.

Rice.—Factorial experiments on rice were carried out under different flooding conditions such as Adani in Onitsha Province, Iboko and Ikwo in Ogoja Province, and at Kwa Falls in Calabar Province. Results from Iboko were particularly interesting, as the experiments confirmed the previous two years' work, where the response to phosphate was highly significant giving 800 lb. increase of paddy for a $1\frac{1}{2}$ cwt. application of superphosphate. The effects of fertiliser on tillering were observed at one experiment and tillering was significantly increased at 5 per cent level by nitrogen applications. Further work on this aspect of increasing rice yields has been recommended by means of micro plot experiments.

Jute.—Two jute experiments were laid out one at Iboko in Ogoja Province the other at Aguleri in Onitsha Province. Neither experiment gave a harvest that could be statistically analysed but information on water control in the case of Iboko was obtained and at Aguleri vegetation response was such that it appeared that higher rates of fertiliser applications could be made.

Cassava.—The residual effects of fertilisers supplied to previous year's yam experiments were observed and recorded on all sites. It has been found on several occasions that when cassava is planted early as an intercrop, significant response to nitrogen has resulted.

In each province a 4 by 6 randomised Block Experiment was laid down with application of sulphate of ammonia direct to cassava sticks. The visual results to date indicate that satisfactory response can be expected.

FERTILISER PLACEMENT STUDIES

A number of placement experiments were laid down in Onitsha and Owerri Provinces on yams and cassava. Indications and results to date confirm earlier work that placement in a ring-round plant is more effective than broadcasting.

FRUIT JUICES

The analysis of juice from five varieties of lemons at regular intervals started in the previous year was continued together with monthly samples sent to a commercial firm in the United Kingdom. All samples maintained the high citric acid content demanded by the trade in the United Kingdom. When yield, flavour and colour were taken into consideration it was clear that Nigeria can produce good quality juice acceptable to commercial firms.

A considerable number of orange and tangelo juice analysis were made together with flavour gradings for the Botanical Section.

MISCELLANEOUS

The laboratory analysed numerous soil samples in connection with projects and field experiments.

Various analysis of feeding stuffs, fertilisers, farm-yard manure and silages were made for Agricultural Officers of the Eastern and Western Regions.

A complete analysis of some eighty pasture grasses was made for Agricultural Officer, Ilorin in connection with the grazing and feeding trials of the Ilorin Stock Farm.

SOIL STUDIES—H. Vine and J. M. L. Kowal

Investigations of Exchangeable Bases in Oil Palm Soils

For some years, shortage of staff has made it difficult to undertake detailed analytical work requiring the prolonged attention of a qualified Chemist at this laboratory, and with the arrival of one of us (J. M. L. Kowal) the opportunity was taken to initiate such work—namely, determinations of exchangeable bases, with particular reference to potash, in soil samples from some important oil-palm experiments.

Methods.—Some previous work had shown the amount of exchangeable potash to be very low in soils of the Benin (or "Acid Sands") Type. It was therefore necessary to investigate the methods of analysis in the first place. The volumetric cobaltnitrite method for potash was adopted. The procedure described by Piper (1941)* with certain variations were first tried, but these gave inconsistent results. A method in use at Aberystwyth and at the Imperial College of Tropical Agriculture, Trinidad, was then tried and found to meet requirements very well. In this procedure, the potassium is precipitated with the usual reagents and the mixture then evaporated to dryness, after which cool dilute acetic acid is added and the insoluble residue filtered and washed. The determination is completed by titration with permanganate and oxalic acid. Tests showed that the K : Na ratio in the precipitate was practically 2 : 1 in the whole range of concentrations met with, and that no correction factor was necessary as in Piper's and other variations of the method.

An experiment was carried out to compare N/2 Acetic Acid, Normal Ammonium Chloride, and Neutral Normal Ammonium Acetate as leaching agents. The latter was found to extract the greatest amounts of bases (calcium, magnesium, and potassium) and was therefore adopted for further work.

Using 50-gm. samples of soil and large filter papers (24 cm.), to give a thin layer of soil, leaching was done with successive portions of reagent (250 c.c. for the first, then about 70 c.c. for each), and the 1st, 2nd, 3rd, and 4th lot of 500 c.c. of leachings were collected for separate analysis. A surprising result was that the bases, especially calcium, continued to be extracted in appreciable amounts, the fourth 500 c.c. giving nearly as much of each base as the third 500 c.c. It was shown that this result was not due to impurities in the reagents, and the same result was still obtained if the soil was first shaken very thoroughly or heated to 60°-80°C for two hours with the reagent.

* Piper (1941) "Soil and Plant Analysis", Adelaide.

It was concluded that the readily extracted forms of K, Ca, and Mg were almost completely removed in the first 1,000 c.c. of leachings and that beyond this stage only the forms difficult to extract continued to be removed. It is assumed that the latter are much less readily available (or practically unavailable) to plants than the former. It cannot be suggested at this stage what the difficult to extract forms of K, Ca, and Mg are in these soils ; but it should be pointed out that the samples were from sites which had had no lime or phosphate applied, and were soil types which are extremely weathered, being derived from very deep soft, more or less clayey sands or sandstones.

The final procedure used was therefore to leach 50-gm. samples of soil with 1,000 c.c. of Neutral Normal Ammonium Acetate.

"Bronzing Disease" of Oil-Palms at Nkwele (Onitsha)

Soil samples were collected in 1943 from fifteen plots in the large experimental block (planted 1931-32) at Nkwele, in which severe "Bronzing Disease" had appeared, accompanied by a very marked decline in yields. Six plots had been treated with ground rock phosphate ; the others were unmanured. Notes were made of the condition of the palms in each plot, at the same time, which varied from good to very bad. There was no correlation between the condition of palms and pH value, Total Exchangeable Bases, or Carbon or Nitrogen content.

Other work including applications of wood-ash in the main experiment and of sulphate of potash in a minor experiment together with leaf-ash analyses done at Rothamsted, has shown clearly that "Bronzing Disease" is the result of potash deficiency.

The results now obtained give a strong indication that the Ca : K ratio is important, not only amount of exchangeable K ; the lower limit of exchangeable potash for healthy growth of palms in the soil under local climatic conditions of Nkwele appears to be about 0.11 mgm.—equivalents per 100 gm., in the presence of about 1.0 mgm.—equivalent of exchangeable calcium or 0.18 mgm. equivalents when the exchangeable calcium is about 3.0 units. This requires to be amplified by further similar work on oil-palms in other places.

Studies of Soil Changes under different Methods of Establishment of Oil-Palms in West African Institute for Oil-Palm Research Experiments

Soil samples were collected in 1941, 1945, and in 1951 from the two original experiments at the West African Institute for Oil-Palm Research, Benin, comparing various methods of establishment of oil-palms, 10 or 12 cores being mixed to form a composite sample for each plot. Routine analyses and determinations of exchangeable potassium, calcium, and magnesium have been done on these. The data do not show very marked differences between the treatments or between the different years of sampling, except in the case of "Intercropping to Exhaustion", where there has been a detectable drop in carbon, nitrogen, and exchangeable calcium in the course of ten years (largely attributable to erosion). One of the most interesting points revealed is that the exchangeable potash content of the top 6″ of soil in these experiments is only just above the amount found to be limiting for healthy growth in the Nkwele oil-palm experiments.

BOTANY SECTION

Botanical Work in the North

STAFF

W. E. Freeman	*Senior Botanist*
J. H. Gisborne	*Botanist*
A. R. Maurer	*Botanist*
H. E. King	*Cotton Breeder (E.C.G.C.)*
J. Saunders	*Cotton Breeder (E.C.G.C.)*
O. J. Webster	*Agronomist (E.C.A.)*

Mr Freeman acted as Assistant Director of Agriculture (Experiments) from 1st April to 1st October.

Two Botanists were stationed at Samaru during the period under review. Mr A. R. Maurer handed over to Mr J. H. Gisborne, Acting Principal Agricultural Officer from 13th August, 1951 to 14th January, 1952 while he went on vacation leave. The Empire Cotton Growing Corporation's work was conducted by Mr H. E. King with the assistance of Mr J. Saunders. Professor O. J. Webster visited Nigeria under the aegis of the Economic Co-operation Administration and was stationed at Samaru from 19th April to 7th December During this time he conducted extensive experiments with sorghum and made recommendations for a millet breeding programme. He also advised the maize breeder at Ibadan. Unfortunately a Botanist was not available to take over this work but it is hoped to remedy this soon.

The Weather.—The rains came later than usual and planting of millet was delayed until the second week in May. The following were the dates of planting :—

Millet, 9th May, 1951.
Guineacorn, 25th May-15th July, 1951.
Groundnuts, 22nd-29th June, 1951.

As elsewhere in the North, the wet season was prolonged with good rains in late September and eleven wet days in October.

RAINFALL SAMARU, 1951

Months	*Inches*	*Wet Days*	*Total To-Date*	*Previous Average to* 1950	
				Inches	*Total To-Date*
January	0.00	0	0.00	0.00	0.00
February	0.00	0	0.00	0.04	0.04
March	0.1	1	0.1	0.33	0.37
April	1.1	2	1.2	1.26	1.63
May	5.53	13	6.73	4.92	6.55
June	4.13	11	10.86	6.51	13.06
July	8.72	19	19.58	8.68	21.74
August	11.06	21	30.64	11.96	33.70
September	11.26	17	41.9	8.53	42.23
October	3.76	11	45.66	1.34	43.57
November	0.01	1	45.67	0.03	43.60
December	0.00	0	45.67	0.00	43.60
Total ...	45.67	96	—	43.60	—

The wet weather was beneficial to guineacorn, groundnuts and cotton, but spoiled the tobacco and sunflower experiments. The yields obtained from the permanent rotation plots were :—

Guinea-corn 1,243 lbs/acre dry grain.
Cotton 431 lbs/acre seed cotton.
Groundnuts 666 lbs/acre shelled nuts.

COTTON—H. E. King

The programme of work conducted by the Empire Cotton Growing Corporation was concentrated on the more promising small bulks of 26c material likely to give some immediate advance in yield and an improvement in lint quality and uniformity without change of general character. A replicated trial containing thirty-three of these was planted together with a series of parallel plots for seed multiplication and single plant selection work. Some mixtures each containing seed of several separate derivatives of 26c were also under trial. Seed stock trials of 26c and its derivatives were carried out at Samaru and Daudawa.

Various minor investigations were continued and by arrangement with the Senior Chemist, a test of the effect of applications of sodium on shedding was laid down.

Full details of the results of the season's work have been published in the Empire Cotton Growing Corporation "Progress Report from Experiment Stations, Season 1951-52".

SORGHUM—O. J. Webster

The following notes are taken from a report prepared by Dr Webster, E.C.A. Agronomist :

Sorghum (locally called guineacorn) has been grown in Northern Nigeria as one of the staple foods of the people for centuries. In years when yields are low there is hunger and very often famine. Natural selection has played an important role in establishing varieties which are peculiarly adapted to each locality. Little has been gained by shifting local varieties from one area to another within the country. It will be quite difficult to get farmers to change varieties when they are quite satisfied with those that they are growing which are no doubt as good or better than any others for their needs.

Most of the sorghums are planted soon after the beginning of the rains and mature at the end. In the north (Sokoto, Daura, and Maiduguri) the rains usually begin sometime in June and end in September and during this period there is an average precipitation of 20 to 25 inches. At the extreme southern edge of the sorghum belt (Yandev, Mokwa and Ilorin) the rains begin in April or May and end in October with an average precipitation of 45-55 inches. The growing period of the varieties therefore ranges from three and a half to six months. Sorghums are planted at the beginning of the rains when the nitrogen content in the soil is at its maximum. Delayed plantings grow slowly and are often injured by numerous insect pests. When a crop matures during the rainy season it must be harvested and dried under cover or else the grain will weather or mould, and may even sprout in the panicle.

Most Nigerian varieties have tall stalks with twenty-five to thirty leaves. The stalks are used extensively in building fences around the compounds (family huts) or in the construction of the frame work of the mud huts. The panicle type of the varieties grown in the higher rainfall areas (30-55 inches) is very lax. The rachis generally extends the full length of the panicle. This type of panicle does not harbour insects and dries out quickly following rains which inhibits the growth of moulds. In the drier areas of the extreme north varieties are found with very compact heads. The grain in the open panicle types is often flat and in some varieties tends to make a quarter of a turn in the glumes when mature. All possible colours of sorghum grain are found in Nigerian varieties. Many fields are quite pure for type but in others a complete range of colours may be found.

For human food a white grain with no subcoat or testa is generally preferred in most areas. A yellow endosperm type has been found in Kaura and Short Kaura. To the knowledge of the writer no reports of endosperm colours have previously been recorded. This characteristic may be of value in improving the varieties of the United States if vitamin A is associated with the yellow colour as it is in yellow maize. Of the 150 or more Nigerian types or varieties examined only two have the sweet juicy stalk characteristic found in sorgos. These two originated from the Maiduguri area where they have been grown for many years.

There will not in the foreseeable future be a need for varieties in this country which are suited for machine harvesting. In a country where the inhabited areas are densely populated and the farms are small mechanisation is not economical. If it were possible to go into undeveloped areas suited for agriculture and plant large acreages of sorghum then machine harvesting could be used but the land tenure system and the nature of the people prevents any large scale farming.

After a survey of the sorghums growing in Nigeria, the breeding programme has been set up with two objectives :—(1) to develop varieties better adapted to the resettlement areas, particularly Mokwa and Shendam and (2) to develop varieties similar to those now being grown but with the Sorgo characteristic of sweet juicy stalks.

The first named objective would apply to areas where the settlers grow from five to fifteen acres of sorghums and there is no need for tall stalks for building purposes. Shorter varieties would be easier to harvest and grain losses from stalk lodging would be reduced. At the Shendam project sorghum stalks grew from 20 to 30 feet in height and there was considerable lodging following a neavy wind in late October. Losses in grain may run as high as 15 to 20 per cent. In these areas, if necessary the farmers can be required to completely clear the land of stalks following harvest to control certain insects and diseases in which case a short stalked type would be easier handled.

The second objective is aimed to assist mixed farming when this becomes general practice, as there is no better crop to supply roughage during the dry season than a sorgo. In the early part of the dry season the stalks could be grazed or fed as bundles in feed lots, and then sorghum silage could be fed at the end of this period. The sorghum fields are at present time grazed by the Fulani herds but sorgo types would be more palatable than the dry stem types now being grown. A sweet juicy stalk dries more slowly than a dry pithy one and palatability decreases with the loss of moisture in the stem. It is for this reason that the above recommendation of feeding or pasturing stalks early in the dry season and using silage towards the end was made. It has been suggested that a sorgo is more susceptible to stem borers than a dry stem type. Some evidence of this was noted this year but there is also a variation in the susceptibility of sorgo varieties. This will require a careful study in the development of a local type with the sweet juicy character.

Scope of the 1951 Sorghum Investigations

Seed of 155 strains and varieties were brought from the United States by the writer and planted at Samaru. Forty-one were new introductions to the United States from Turkey and India. Most of this group were classified as durra or broom corn. The durras proved to be entirely unsuited to the Samaru area since they have very compact heads which became mouldy during the wet season, and were very susceptible to a leaf spot disease tentatively identified as grey leaf spot (*Cercospora sorghi*). This disease completely defoliated many of the rows before the grain was mature. The local varieties and those commonly grown in the United States were quite resistant.

A second group of thirty-five varieties included those of the 1951 Uniform Nursery grown in the United States at twenty locations ranging from South Dakota to Texas, and California. The varieties include the most promising ones which have been currently developed by the sorghum breeders in South Dakota, Nebraska, Kansas, Oklahoma and Texas. The object of growing this nursery in Nigeria was to compare the effect of a twelve-hour day length at 12 degrees latitude with the longer days at latitudes ranging from 29 degrees in Texas to 43 degrees in South Dakota. These varieties at Samaru grew to about the same height and their relative maturity was about as would be expected in the United States. They matured in August when the rains are the heaviest and will be of no use in this area. A delayed planting made on 20th July matured a fair crop in October but early growth was slow and small larvae killed the main stem of most plants.

A third group of ninety varieties included kafirs, hegaris, milos, feteritas, shallus, sorgos, and hybrid derivatives for the purpose of observing their performance under Samaru conditions. In the future it will be possible to send additional material for those types which are best adapted. Under the short day length of twelve hours tillering was reduced in the hegaris and milos. The variety Gurno was the only one which tillered as it normally does under 14 to 15 hour days. The short days were a factor in bringing Hegari and Early Hegari, and Dwarf Yellow milo and Double Dwarf Sooner milo into flower at the same time. Under long days there may be as much as two weeks difference in their time of flowering. Although all varieties matured too early to be of any practical value at Samaru, certain varieties were outstanding for yield. The hegaris planted in single 10 yard rows gave yields of 2,000 pounds per acre in seventy-five days from planting which compared favourably with the yield of the local variety Farafara which required 140 days to mature.

The kafirs, Sudan Red and Pink also gave good yields. Nearly all of the early varieties of this group would have given yields comparable to those harvested from similar nurseries in the sorghum growing area of the United States. The later maturing varieties were severely damaged by stem borers (*Busseola fusca*) and some failed to set seed. The larvae of those insects bored into the peduncle as the plants were heading and prevented translocation of water and nutrients to the panicle. The shallus, probably because of having a peduncle with a small diameter were most severely damaged. Green weights were taken on three sorgo varieties and yields average about 7-10 tons per acre. This is a fair yield but the total green weight of a much taller later maturing local variety would exceed that tonnage.

A collection of 160 Nigerian and Gold Coast varieties were planted in single rows. A complete set of notes was taken on all vegetative and seed characteristics so that some type of classification can be prepared. All varieties were examined at the time of maturity for stem borers. There are none which have good enough tolerance to be used in a breeding programme.

The remainder of the Nursery at Samaru included two small replicated yield trials of local varieties. These experiments were designed to determine not only varietal performance but also the optimum plot size and number of replications to use in testing varieties.

A growth rate study was made of thirteen United States varieties and four from Nigeria. The American varieties averaged 2.1 new leaves per week for seven weeks, while the local varieties averaged 1.6 leaves per week over a period of eighteen weeks. The most rapid growth of a sorghum plant is at heading time.

Twenty-eight crosses were made between the Nigerian varieties Farafara, Short Kaura, the Gold Coast variety 9E, and several American varieties. The object of these crosses will be to develop the type of varieties which has been requested by the Mokwa and Shendam resettlement areas and for transferring the sorgo characteristic of sweet juicy stalk into the local varieties. A part of the F_1 seed has been sent to Lincoln, Nebraska, U.S.A. where it has been planted in the greenhouse for producing F_2 seed and for making certain backcrosses while the remainder is being planted at Samaru where it can be irrigated during the dry season. F_2 and backcross seeds will be available for planting in June of 1952. By following the outline which has been prepared the objectives of these crosses should be attained in four or five years.

A detailed report of the 1951 sorghum work in Nigeria will be prepared as soon as all the data have been collected. It is expected that this report will serve as a pattern for future reports which will be prepared, and the writer has requested a copy each year in order to review the progress of the improvement programme and make recommendations on its conduct if such seem necessary.

Sorghum Nurseries conducted at Other Stations

Seed of about forty-five American and Nigerian varieties was supplied to the agricultural experiments stations at Riyom, Kano, and Daura. The appearance of these varieties at the different locations was similar to what one would expect from such a nursery in the sorghum growing area of the United States.

The station at Riyom is located on the Plateau at an elevation of about 4,000 feet, the soil is infertile and the precipitation averages 55 inches. There are no sorghum varieties grown in this part of the Plateau because there is probably not enough fertility to support the plant growth of most Nigerian varieties. The introduced varieties grew quite normally and produced well developed heads. This nursery did receive a dressing of manure but it will remain for another year's test to observe how well the short, early maturing American varieties will do on the infertile soils of the local farms. There is a possibility that one of the introduced varieties may find a place in the agriculture of this area. The acreage per farm would have to be low since the grains will mature during the rains and must be harvested and dried under cover.

The varieties are better adapted at Kano and Daura where the rainy season is limited to three and a half to four and a half months. The only possible place any of the early maturing varieties may have is in areas of Northern Nigeria where the rains are limited to about three and a half months. Millet is the predominate food crop in this area and the

local sorghum varieties require at least average or above average precipitation. Plans have been made to test in 1952 ten or twelve of the best varieties in yield trials at eight locations in Northern Nigeria and two in Northern Gold Coast. These tests will indicate if any of the American varieties will have a future in Nigeria.

Future Programme of Work—A. R. Maurer

In addition to carrying out trials of introductions, hybridisation and selection for suitability for local conditions, special attention is being paid to tests for resistance to pests such as stem-borers, Striga root parasites, and smut diseases of the grain, and to the development of short-strawed types suitable for mechanised farming. In general, this programme of investigation conforms closely to the recommendations of the Sorghum Mission.*

Work has already started on this programme at the Northern Regional Research Station at Samaru, with outstations at Daura, Kano, Riyom and Mokwa. It is hoped to appoint a Botanist to take special charge of this work in the latter half of 1953.

During his stay in Nigeria, Dr Webster drew attention to the yellow pigmentation in the endosperm of short Kaura. Further work in the United States of America shows this pigment to be Carotin and it is stated that the quantity contained is on the same level as that in yellow maize. Considerable importance is attached to this and a breeding programme is now being conducted by Dr Webster on short Kaura in the United States.

MILLET (*PENNISETUM TYPHOIDEUM*)

Selection of early maturing types continues. As millet is an out pollinated crop, which behaves very much like maize in fertilisation, the programme of breeding undertaken in the past is leading us to the production of a number of in-bred lines. It is hoped that these separate lines will, when crossed, produce early maturing hybrids. These hybrids would be subject to selection before being ready for distribution.

Dr Webster has studied the millet breeding programme and has made recommendations for the future.

MAIZE

A further trial, using the five varieties obtained from U.S.A. in 1949 and some crosses between them, was carried out. Very high yields were obtained in this experiment, due to good stands, heavier rainfall and more skilful management than in the past.

Summary of Yields (Adjusted Yields) expressed in lbs/acre

Variety	*Yields*
Kansas 2234×Indiana 750A	2,592
Indiana 703B	2,398
Indiana 901A	2,283
Indiana 750A	2,251
K2275×1901A	2,218
I750A×I 703B	2,147
K2234×I 901A	2,139
Puerto Rico Yellow	2,076
K2234	2,025
K2234×K2275	1,986
K2275×K2234	1,981
K2275×I 750A	1,973
K2234×I 703B	1,855
K2275	1,831
No. 2503	1,554
S.E.	±129
Significant Difference at 0.1%	642
Significant Difference at 1%	488
Significant Difference at 5%	367

* A. H. Saville and H. C. Thorpe, "Report of the Sorghum Mission to certain British African Territories", Colonial Advisory Council Pub. No. 2, 1951.

The Indiana strains were more consistent performers than the original Kansas strains, probably due to their tallness, initial vigour and slightly higher percentage shelling: 58 per cent as compared with 54 per cent for the Kansas.

RICE

Artificially controlled paddy beds have been constructed at Samaru. These beds vary in depth of water from half a foot to four feet and it has been possible to maintain most of our new introductions in these beds.

New seed of G 79 obtained from British Guiana is being multiplied here and will be distributed to Maigana in 1953. It is hoped that this strain will be kept pure, and Botanist's staff will, in future, assist Agricultural Officer, Maigana with roguing. The yields of upland rice varieties on the farm were poor, ranging from 44 lbs per acre to 242 lbs per acre.

GROUNDNUTS—A. R. MAURER

GROUNDNUT VARIETY TRIAL NO. A1 (51)

This is a continuation of series of variety trials at Samaru. The same varieties were grown in 1951 as in 1950 and the following table shows the results from 1945 onward :—

Year and No. of varieties in trial	*Order of Merit*							1951 *un-decorated nuts in lbs./acre*	1951 *kernels in lbs per acre*	1946-51* *average wt. kernels per acre*
	1945	1946	1947	1948	1949	1950	1951			
	49	25	25	12	15	15	15			
MK 383	8	15	2	7	2	1	2	1,327	892	949
MJ 371	12	2	10	6	3	2	5	1,306	889	934
Kano 50 (MD351) ...	—	—	—	—	—	9	3	1,318	884	916
Castle Cary	48	10	6	1	6	4	9	1,175	797	886
Samaru 38	45	11	5	4	12	5	6	1,268	816	876
MJ 374	1	1	7	2	4	3	13	1,129	772	876
MG 371	6	4	20	5	10	11	4	1,318	843	864
Kano 38	—	6	1	9	7	7	10	1,153	735	858
Natal Common ...	—	—	—	—	1	14	15	924	647	857
MK 374	8	5	3	11	5	8	12	1,138	764	854
ML 372	3	2	15	12	11	15	1	1,337	833	849
ML 378	2	8	17	7	8	6	8	1,221	771	847
ML 3710	4	12	19	3	13	13	11	1,147	806	841
ML 384	5	16	4	10	9	10	14	1,116	707	818
Samaru 38 (Ex Kontagora) ...	—	—	—	—	—	12	7	1,225	811	793

S.E.	±42
Significant Difference at 0.1%	197
Significant Difference at 1%	160
Significant Difference 5%	120

It is interesting to note that Natal Common has fallen to the bottom of the list. This variety was introduced in 1948 and did extremely well in 1949. MK 383 is maintaining a good position and if it does well again in 1952, it will be distributed in 1953.

GROUNDNUT VARIETY TRIAL NO. A6 (51)

This trial was undertaken to test some of the newer varieties and some local types collected in the North. Castle Cary was used as a standard variety for comparison and it yielded better than any others.

* 1945 yields are not included here because of bad flooding that year.

Summary of Yields in lbs/acre

Groundnut Variety	*Nuts*
Castle Cary	2,156
Dixie Runner	2,112
Toro	2,007
Mache Atsugune	1,992
MPA	1,972
Yipa	1,943
Tudun Wada	1,934
MPB	1,918
Valencia	1,895
MPU	1,812
Kano	1,733
Castle Cary ex Bida	1,706
Spanish 205	1,700
Natal Common	1,671
Phillipine White	1,073
S.E.	±77
Significant Difference at 0.1% point	357
Significant Difference at 1% point	289
Significant Difference at 5% point	217

Phillipine White and Castle Cary ex Bida are not as intrinsically poor as the above results apparently show, the initial poor germination and subsequent difficulties in establishing good plant population due to lack of viable seed, gave them a bad start in life. Apart from Phillipine White, Natal Common had the lowest yield.

Hybridisation

This work continues but time did not permit the Botanist to concentrate on this work. It is hoped that information on technique will be obtained this season. To date, a few successful crosses have been made and they will be planted out in 1952.

Apparatus and chemicals are being assembled to carry out a genetical study of all our groundnut varieties. This fundamental information should be of value in any future breeding work undertaken in Nigeria.

SOYA BEAN

Variety Trial No. A10 (51)

Five varieties which have been yielding well in our observation plots were tested against Benares to determine whether they could be distributed to other stations in 1952.

Results were significant and Benares came fifth out of six varieties. Bilomi No. 3 was the highest yielder with 1,148 lbs threshed beans per acre.

Summary of Yields in Lbs/Acre Threshed Beans

Soya bean Variety	*Yield*
Bilomi No. 3	1,148
Misc. 94	1,088
Bilomi No. 1	1,021
Black Matted Java	983
Benares	946
Yellow Bermley	798
S.E.	±22
Significant Difference at 0.1% point	270
Significant Difference at 1% point	200
Significant Difference at 5% point	146

Spacing Trial No. A 9 (51)

This experiment is a repeat of A 7 (50). Four varieties were grown at three different spacings.

Summary of Yields in Lbs/Acre Threshed Beans

Treatments (spacing)	*Yield*
3″	982
6″	913
12″	770
S.E.	±23
Significant Difference at 0.1% point	127
Significant Difference at 1% point	99
Significant Difference at 5% point	75
Soya bean Variety	*Yield*
Benares	974
Avoyelles	962
Mamloxi	786
Acadian	851
Dixie	862
S.E.	±23
Significant Difference at 1%	128
Significant Difference at 5%	97

Results confirm previous data which show that closer spacing tends to give higher yields of the four varieties tested, Benares gave the highest yield at 974 lbs threshed beans per acre.

BENISEED

Selection Work

The early maturity and normal maturity selection work at Yandev continues. In both cases there is an indication that earliness and heavy yielding factors are being maintained in some of the selected strains.

Further selection work was done in 1951 and in 1952 it is hoped to have a yield trial and a Strains versus Families trial.

TOBACCO

Variety Trial No. A(51)

This trial was a failure due to excessive water-logging. Selfed seeds were kept for 1952 planting but harvesting was not attempted. The trial will be repeated in 1952.

SUN-FLOWERS

Variety Yield Trial A13 (51)

Five varieties were grown but due to heavy rains at harvest time, proper yields could not be recorded. The heads rotted before they could be dried and weighed.

Summary of Yields Lbs/Acre Threshed

Sunflower Variety	*Yields*
Grey Seeded	1,147
Saturn	846
Hungarian	406
Sunrise	165
Advanced Hybrid	350
S.E.	±24
Significant Difference at 1% point	322
Significant Difference at 1% point	228
Significant Difference at 5% point	162

PLANT INTRODUCTIONS

A large number of introductions of Rice, Maize, Tobacco, and Guineacorn were made for trial in the Northern Region.

Botanical Work in the South

STAFF

T. A. Russell	*Senior Botanist*
J. M. Waterston	*Senior Botanist*
C. A. Thorold	*Plant Pathologist*
A. J. Vernon	*Botanist*

Dr J. M. Waterston acted as Assistant Director of Agriculture (Cocoa) from 13th August to 1st October, 1951, and (Experiments) from 2nd October to 31st March, 1952.

Two Botanists were stationed at Ibadan throughout the year, Mr T. A. Russell being responsible for administration of the Botany Section and work on permanent crops, and Mr A. J. Vernon for work on annual food-crops. During Mr Russell's absence on leave, the Section was administered by Dr J. M. Waterston and the work on cocoa was supervised by Mr S. S. Parker. The African Assistants were given much responsibility in carrying out the experimental work and the progress made is a measure of their efficiency and diligence.

The Botanist at Ibadan continued to be responsible for the Botanical Work for the Eastern Region as well as for the Western. While most of the work was done at Ibadan in the West, the crops handled are of equal importance to both Regions and, where climatic conditions are so similar, it does not matter greatly at which place the work is centred. Investigations on yams, cassava, and leguminous crops were made at Umuahia in the East under an Agricultural Assistant.

At Ibadan the season was notable for its good rains, the total fall in 1951 amounting to 60.10 inches as compared with a mean figure of 45.90 inches for the previous ten years. September and October were unusually wet and, though unbroken drought then set in, it was cut short by good showers in February and March. As a result the permanent crops suffered less than usual in the dry season and early planting of annual crops was possible.

RAINFALL, MOOR PLANTATION, IBADAN, 1951

Months	*Inches*	*Wet Days*	*Cumulative Total*	*Previous Average : 10 years (1941-50)*	
				Average	*Cumulative Total*
January	0.44	2	0.44	0.43	0.43
February	0.00	0	0.44	0.61	1.04
March	1.87	8	2.31	2.10	3.14
April	5.41	9	7.72	5.46	8.60
May	6.88	13	14.60	6.52	15.12
June	5.84	12	20.44	6.67	21.79
July	14.07	14	34.51	5.06	26.85
August	3.37	15	37.88	3.30	30.15
September	11.70	20	49.58	7.53	37.68
October	9.32	20	58.90	6.27	43.95
November	1.20	4	60.10	1.71	45.66
December	0.00	0	60.10	0.24	45.90
Total	60.10	117	—	45.90	—

Corresponding figures for rainfall at Umuahia where the Research Station for the Eastern Region is to be located are shown for comparison.

RAINFALL, UMUAHIA (UMUDIKE), 1951

Months	Inches	Wet Days	Cumulative Total	Previous Average : 27 years (1922-1949)	
				Average	Cumulative Total
January	0.76	4	0.76	0.97	0.97
February	4.35	6	5.11	2.13	3.10
March	2.08	8	7.19	4.58	7.68
April	5.63	10	12.82	8.01	15.69
May	11.33	22	24.15	10.24	25.93
June	14.67	22	38.82	12.58	38,51
July	10.61	22	49.43	11.40	49.91
August	18.71	24	68.14	11.44	61.35
September	11.77	28	79.91	13.70	75.05
October	13.74	26	93.65	11.42	86.47
November	5.24	10	98.89	3.40	89.87
December	0.00	0	98.89	0.80	90.67
Total	98.89	182	—	90.67	—

The first part of the report which follows deals with food-crops. In this work prominence was given to the improvement of maize with special reference to its resistance to rust, *Puccinia polysora*. This disease occurred first in devastating form in 1950 and was once more prevalent on maize throughout the country in 1951, though the actual loss sustained by its attack was probably less. It presents the most immediate pathological problem in Southern Nigeria and merits the whole time attention of a plant pathologist.

So far only the uredo-stage of the rust has been seen in Nigeria. No germination was obtained from uredospores kept for six months on withered leaves in the laboratory and this suggests the likelihood that uredospores are unable to survive the dry season where no maize crop is in the ground. It was of interest to find, however, that here and there a few maize plants are grown even at the height of the dry season in damp places beside rivers or in the irrigated gardens. Heavy infection was found on such plants and they may well prove to be the means whereby rust is carried from one maize crop to the next.

WORK ON FOOD-CROPS

The Department of Agriculture was fortunate in obtaining the services of Dr O. J. Webster, Technical Assistant attached to E.C.A. who prepared the following report on a programme for Maize Breeding in Nigeria :—

MAIZE BREEDING FOR NIGERIA—O. J. WEBSTER

The suggested breeding procedure outlined herein for maize in Nigeria is based on observations made of maize growing in the Southern Provinces during the third week of May, and from discussions with the maize breeder and other members of the Department of Agriculture at Ibadan. Since the impressions of the problems involved may not be entirely in agreement with the true facts some modification will no doubt be necessary as the breeding programme progresses.

Maize in Southern Nigeria is planted at the end of March or in April depending on the beginning of the spring rains. The second crop, planted in late August or early September, does not give yields of grain equal to those harvested from the first. In the areas near populous centres much of the crop is harvested at the soft to hard dough stage and eaten after roasting. For this, white flour and flint types are generally grown. The flour types such as Lagos White are better for hand grinding when mature than the flints but they are more subject to insect attack when stored as dry grain. Dent varieties are not grown to any extent. The breeding programme should be concentrated on the development of productive white and flint varieties but the investigations of dent varieties should be continued. The tastes of the native population are so variable from village to village that it may be difficult to get an improved variety which will be accepted over a very wide region. It is hazardous to grow a single variety over a large area because of disease and it will be desirable to develop more than one good variety for a given area.

The soils in Southern Nigeria are low in fertility. The maize is often planted on new land cleared of bush and on most farms is interplanted with cassava or yams. Yields of 2,000 pounds of grain per acre are about the maximum expected on Moor Plantation at Ibadan. On surrounding farms yields may be less since soil fertility is not maintained at as high a level. In this area maize planted in early April tassels at the end of May or early in June. The plants grow from 10 to 14 feet in height. On plants of such size examined in the Ilaro Division of Abeokuta Province the ears were relatively small. It would appear that in many fields there is adequate fertility for developing normal plants but not enough for maximum ear development. Under these conditions an early maturing maize may yield as much or more and have the added advantage of providing a food crop at an earlier date in the season. In the corn belt of America an application of a nitrogen fertiliser about two weeks before tasseling very often gives increased yields without much increase in plant size. Nitrogen applied at this same time to maize in Nigeria may be an efficient way to use this element. Experiments are being conducted in the maize growing area in order to determine the optimum rates of applications of commercial fertilisers on this crop and the most effective time of application.

In the breeding programme an effort must be made to develop varieties resistant to corn rust *Puccinia polysora* Underw. In 1950 this disease for the first time on record threatened the maize crop in Western Africa and in 1951 it is again developing into epidemic proportions. Infection usually does not occur until near the tasseling stage and although it normally does not cause a complete crop failure yields undoubtedly are reduced.

The maize breeder in Nigeria has a real challenge before him but by using the sources of materials available and applying the modern techniques of plant breeding the improvement programme should make rapid progress.

Past, Present, Future Breeding Programme

To the knowledge of the writer the only improvement work in recent years has been one of selecting in local varieties, and the observation and testing of a few introductions. There are a few distinct varieties being grown and the maize on many farms is a heterogenous mixture of plant types and seed colours.

An extensive collection of seed of maize hybrids and open pollinated varieties was planted at Ibadan in April in plots replicated two or more times. The primary purpose of this planting is to compare the performance of these introductions with that of the local varieties. The entries included in the test plot are thirty-two and in addition twelve hybrids from the state of Nebraska, U.S.A. were grown.

The Michigan hybrids when grown in the northern corn belt state of America have a range of silking date of nearly two weeks. In the test plot they all tasseled about the same time ; 15th to 19th May. Their plant height was about the same as when grown in Michigan. Although these hybrids are early each plant has the potential of a good ear and yields of 1,500-1,800 pounds of grain can be expected. A heavier rate of planting would have given higher yields. The United Hybrids which are quite typical of those grown in the American Corn Belt area were no earlier than the local strains. It will be of interest to compare their silking dates, ear and plant heights. The Nebraska hybrids were not planted until about 1st May.

Seed of all open pollinated varieties is to be increased and maintained by pollinating several ears with a bulk collection of pollen from eight to ten tassels. Inbreeding work will be started using local and those introduced varieties which are best adapted.

The suggested breeding and testing programme may be divided into these phases :

(*a*) Introduction and testing of hybrids and open pollinated varieties from diverse origins ;

(*b*) Imrovement of local varieties by developing synthetics from the best ;

(*c*) Development of inbreds from local strains for combining into three-way or double cross hybrids within themselves or in combination with inbreds of the best adapted introduced hybrids.

The most immediate improvement may be accomplished by importing varieties which are superior to those grown locally. Varieties might be found which are superior agronomically but which are not palatable to the tastes of the people. Nearly all corn hybrids from U.S.A. will be of the dent type which may be refused by the local farmers. It is however, quite improbable that maize from the latitude of the Corn Belt Area of America will be adapted to the corn growing area of Nigeria. It will be of value from the information obtained to study the response of these hybrids grown at latitudes near the Equator. The writer has requested additional seed of the twelve Nebraska Certified Hybrids for planting in August and for Spring planting in 1952. These hybrids in their native environment have a wider range of adaptation and are quite representative of those grown in the corn belt. A request has also been made to the Experiment Station located at Raleigh, North California for seed of hybrids now being grown in the northern states of the U.S.A.

At the suggestion of Dr Jenkins, Washington, D.C., a request for seed of hybrids and inbreds has been made from the Corn Breeding Project of the Rockefeller Foundation located at Mexico City, Mexico, and also from the corn breeder in Venezuela. Materials from these latitudes should be better adapted to Nigeria.

A world wide survey has been started to collect maize which may be resistant to the form of rust prevalent in West Africa. When such resistant material is found then a programme will be suggested as to how the resistance can be best incorporated into the breeding project. In addition a request has been made for seed of the differentials to be used in identifying the physiologic form or forms of rust prevalent in Nigeria.

The most rapid advance in the improvement of the local varieties can probably be made by the method outlined by Lonnquist*. This would entail the following steps : self pollinate 150-200 plants or more in an open pollinated variety, at harvest time carefully select from the best plants ears which have the grain characteristics desired (there may be 75 to 100 S_1 ear harvested) ; plant thirty seeds ear to row from each S_1 ear in an isolation block with seed of the open pollinated variety planted in every third row, detassel plants in the S_1 rows, bulk the top cross seed in each S_1 row eliminating those rows undesirable agronomically (these may leave only fifty rows or less to harvest), plant the top cross seed in a well replicated yield test to determine the general combining ability of the S_0 plants ; on the basis of yield performance, bulk equal numbers of remnant seed of 8 to 12 S_1 ears which gave the best top cross performance and plant in an isolation block ; harvest 100-150 ears more or less at random and bulk the seed which is designated synthetic 1 (or *syn* 1 seed) ; plant *syn* 1 seed in an isolation block and harvest 100-150 ears from best plants (*syn* 2 seed) ; plant the *syn* 2 seed in a yield trial with the open pollinated parent and also in another isolation plot. Seed from the isolation would be *syn* 3. If the performance of the *syn* 2 and *syn* 3 is superior to the open pollinated parent the *syn* 3 seed could be released to farmers. A second cycle of improvement could be started in the *syn* 2 or *syn* 3 isolation block. Each cycle should result in some improvement in the variety. The success of this programme is dependent on carefully conducted yield trials of the top cross seed.

The development of synthetics by the above method may be the more practical approach to corn improvement in Nigeria than the production of hybrids from inbreds. Seed from high combining S_0 plants from different varieties which did not differ markedly in their grain type could be put in to a synthetic.

In the local breeding programme at Ibadan this spring inbreeding has been started in the open pollinated varieties Lagos White, Tsolo, and Epoke. From 150 to 200 self pollinations are to be made in each. It is suggested that seed from 75 or more of the S_1 ears from the best plants be planted and top crossed to their respective open pollinated varieties in the second planting made in July or August. The top cross performance trials would then be made in spring of 1952. If space is limited top cross trials should be made of at least Lagos White and Tsolo. A row should be planted from seed of each S_1 ear of

* "The Development and Performance of Synthetic Varieties of Corn," Agronomy Journal *41* : 153-156, 1949.

Tsolo in the Ilesha area where observation notes can be made on corn rust since the parent variety seems to have some resistance. The seed from the S_1 ears which shows the highest yield in the top cross test and resistance or tolerance to rust would be used to develop the synthetic.

On the basis of top cross test from S_1 seed inbreeding would be continued in the lines of the highest combining ability.* Top cross tests of the S_3 and again of the S_5 lines would be desirable for selecting the high combining lines. The lines remaining at the end of the S_5 would then be combined into single crosses between themselves or preferably with lines from maize from other varieties of similar type and put into yield trials. On the basis of single cross performance, the yields of the double crosses could be predicted and actual seed made for testing.

Another inbreeding procedure which is used by some Experiment Stations in the United States is outlined below and may fit in well in the Nigerian Maize breeding programme. It requires a minimum of supervision and no detailed records are kept :

(*a*) Self pollinate 800-1,000 or more plants in an open pollinated variety. Fewer would be required if selfing is to be done in a single or multiple cross hybrid.

(*b*) Carefully select during the growing period and at harvest time S_0 plants for vigour, stalk height, ear position, leafiness, plant colour, stalk strength, disease and insect resistance, etc.

(*c*) From each S_1 ear harvested grow only three to five plants. Sometimes these are planted all in one stand but it would be better if they could be spaced at least one foot apart. Only two plants are selfed in the most desirable rows. Rigid selection is again practised at the time of maturity and only one ear per row is harvested.

(*d*) The above procedure is followed until the S_4 or S_5 generation at which time the original number of selfed lines would have been reduced by visual selection to less than 100. The lines would then be tested in a top cross trial for combining ability.

The success of the progress depends on visual selection in a mass of material. No records are kept on the lines from generation to generation since at the end of the inbreeding period no two lines will stem from the same S_0 plant.

After a line is reasonably well fixed it is the general practice to maintain it by selfing one year and sibbing it the next.

The bulk of the maize breeding should be done at Ibadan or at some other station in Southern Nigeria where land is more plentiful. Since leadership and facilities are available at Samaru it is recommended that a similar improvement programme be started using one or two local maize varieties if available. Tests would also be continued at this latter station with introduced varieties. The work at both stations would be conducted as one co-ordinated programme with leadership from the maize breeder at Ibadan.

In a maize breeding programme it is imperative that the viability of line seed should be maintained for at least three or four years. This may entail the construction of a storage vault at Ibadan or shipping small quantities of line seed to a more temperate climate. All line seed as soon as it is shelled must be treated with some insecticide such as D.D.T.

Other equipment needed in a maize project depends to some degree on the available facilities and cost of labour. It is essential that durable paper pollinating bags be used as well as some type of transparent ear shoot bags. A plier type stapler is the most economical tool to use to fasten pollinating bags on the tassels and over the ear shoot after pollinations are made. An electric moisture tester speeds harvesting when numerous plots are grown. This eliminates the process of hand shelling and air drying the grain.

MAIZE BREEDING AT IBADAN—A. J. VERNON

COLLECTION AND MAINTENANCE OF VARIETIES

Maize being normally cross pollinated, standard varieties can be maintained only in isolation plots or by making hand pollinations. Between October 1950 and September 1951, thirty-seven varieties were imported, the majority from North America, and these, together with a few grown on from previous years, were kept going by these methods (these figures

* Lonnquist, "The effect of Selection for Combining Ability within Segregating lines of Corn" Agronomy Journal *42* : 503-508, 1950.

do not include "hybrid" varieties which can be maintained only in the form of inbred lines). During this period, over thirty "varieties" of local maize were collected by making selections from farmers plots throughout Nigeria. These local selections consisted in some cases of one definite type ; but more often proved to be a mixture of types. In both early and late crops they were carefully studied and further selections made within them ; the object being to standardise a number of lines for future use as "control" varieties against which to compare varieties introduced from abroad or bred in Nigeria.

Variety Trials

Replicated field trials of introduced and local varieties were carried out during both seasons of 1951, about fifty varieties in all being tested in this way. Some varieties appeared less susceptible to rust *Puccinia polysora* than were the majority of local varieties, though differences were very slight and not correlated with higher yields. Many introduced varieties however significantly out-yielded the best local ones in the trials. In the early trial the open-pollinated introductions American White Flint, Jellicourse, Neal Paymaster, Tsolo, Wisconsin White Dent, and Big Joe, together with six hybrids of which M267 was outstanding, gave from 25% to 90% higher yield than the 1,000 lbs/acre average of the twelve local varieties under trial. In the late trial owing to a series of misfortunes, yields were low, the local average being only 380 lbs per acre which was out-yielded by 120 per cent by White Tuxpan, 90 per cent by Tsolo, 65 per cent by American White Flint, and 45 per cent by Big Joe. In spite of rather high experimental errors in both trials, many differences were highly significant ; and although recommendations to farmers cannot be made until another season's work has confirmed these figures, the situation is promising. During the trials valuable information was gained on the subject of experimental methods as a result of which it is hoped to reduce experimental errors in future trials by a considerable margin.

Line Breeding

Inbred lines can be used either to produce "hybrids", in which case the hybrids must be produced afresh each year by special seed-growing establishments, or combined to make synthetic open-pollinated varieties. These latter are not as high-yielding as hybrids but are more suited to present day Nigerian agriculture as the farmer can grow his own seed and does not have to buy in fresh seed each year. The development of inbred lines in Nigeria was initiated by making about 500 self-pollinations in the varieties, Epoke, Nkwele, Lagos White and Tsolo. Those from Epoke and Nkwele were discarded in the second season, their parents having done poorly in the early trial ; and no further selfings were made as it was decided to wait until a greater range of varieties and more information concerning them was available before increasing the scope of the line-breeding. Work with the S_1 lines of Tsolo and Lagos White took the form of crossing them against their respective parents—the "top-cross"—as a preliminary to running top-cross yield trials in the 1952 season ; and 64 S_1 lines of Lagos White and 49 of Tsolo, together with their respective top-cross were carried over to 1952. In addition to our own selfing, the four inbred lines that make M267 were obtained but arrived too late in the year for satisfactory testing. Not planted till late October they grew to maturity but set practically no seed.

Maize Rust Investigations

It was decided that the main attack on the problems of maize rust should be the attempt to import or develop resistant varieties. Apart from the general observations described elsewhere, no experimental studies were made directly on maize rust ; but throughout all the varietal selection and breeding work, differences in varietal response to the disease were looked for, and rust resistance was given priority over all other criteria in making selections.

COWPEAS—A. J. Vernon

Factorial Trial

Previous cowpea variety trials have tended to give most inconsistent results ; and to explore the reasons for this a yield trial was planned having five varieties at three spacings and two planting dates, *i.e.*, thirty treatments all told. Owing to complete lack of rain in late November and December yields were low, particularly of three of the varieties

which were late maturing. Varietal differences, though highly significant, were therefore of little interest; but the other treatments gave a most surprising result, as shown in the following table :—

Yields of Cowpeas at Different Spacings and Planting-Dates

Spacing Treatment	*Average of all Varieties*		*Variety New Era* (1346)	
	Planted 27th August	*Planted 17th Sept.*	*Planted 27th August*	*Planted 17th Sept.*
	lbs/acre	*lbs/acre*	*lbs/acre*	*lbs/acre*
3′×4′	179	56	373	178
1½′×4′	70	94	167	302
2′×2′	52	54	118	185
Significance of differences ...	Significant difference at 5%=26 lbs/acre		Significant difference at 5%=56 lbs/acre	

Thus it would appear that a three weeks difference in time of planting makes a most radical difference in optimum spacing; the later planting requiring a plant population of double the early one. No explanation of this is apparent; but the significance is so high that it cannot be ignored. It is intended to follow up this work before carrying out any more straight variety trials.

Variety Trials

The straight variety yield included eleven varieties, of which New Era (1346) with 240 lbs/acre did best, though not significantly better than Maggs' Marvel at 210 lbs/acre. This was the second time this latter variety, the product of breeding work by Mr D. H. Maggs about ten years ago, had been included in a yield trial and last year it came 4th of twenty-five varieties. All other varieties yielded significantly less. As mentioned above however the weather was unpropitious particularly to cowpeas planted, as these were, a little on the late side. This greatly favoured the early maturing varieties, which occupied the first seven places. Thus the only useful conclusion was that under such conditions quick maturing varieties do best; and New Era is both the earliest and the highest yielding of this group.

Collection and Breeding

The collection was maintained, though it was greatly regretted that insufficient seed was obtained of any of the local varieties collected in 1950-51 to enable them to be included in next year's variety trials. This is particularly unfortunate as this year's trials again emphasised the need to have a greater local representation in variety trials if any recommendations to farmers are to be based on them. The F_1 generations of some crosses of New Era with local varieties made in 1950 were raised and their appearance was quite promising. After they had self-pollinated the F_2 seed was harvested.

CASSAVA—A. J. Vernon

Variety Yield Trial

This was harvested just too late for the results to be included in the 1950-51 Annual Report. The Gold Coast hybrid 997B was again top, being the only variety to beat the Ibadan local variety Karagba. Although the difference in yield was only just statistically significant at the 5 per cent level, when the result is considered in the light of previous trials there can be no doubt as to the practical significance of the superiority of GC 997B. The following table shows the yields in tons/acre of GC997B and Karagba in the varietal yield trials for the past five seasons :—

Yield of two Cassava Varieties in tons per acre

Variety	1946	1947	1948	1949	1950
GC 997B ... ... (A)	15	13	11	8	6.7
Karagba ... ... (B)	8.5	9	8.5	6.5	5.4
% increase of (A) over (B)	76%	44%	29%	23%	25%

The general decline in yields is quite probably accounted for by such factors as plot fertility, weather, length of growing period, and experimental error, but the possibility of it being due to increasing severity of the mosaic disease cannot be ruled out.

The drop in percentage superiority of GC 997B over Karagba from 1946-48 was almost certainly due to the collapse in the mosaic resistance of the former; but in the last three years it appears to have levelled off at about 25 per cent, which although nothing like the original 76 per cent is still quite worthwhile.

A yield trial of twenty-five varieties was planted in May 1951, and will be due for harvest in May 1952. A further small trial of two varieties GC 997B and Karagba, was planted partly to multiply all available stocks of GC 997B and partly to give a really conclusive result regarding the relative merits of the variety most widely grown around Ibadan and the variety which it is intended to recommend to replace it. In addition to these trials the cassava collection was maintained.

WORK ON OTHER CROPS—T. A. RUSSELL

COCOA

A paper is in course of publication describing the performance of the progeny of a cross between Nigerian and Trinidadian Trinitario seedlings and the progeny derived from selfing of the parents. Since this was written another year's records are available and they confirm the results already described. The following table shows the yield of the progenies expressed as pounds dried cocoa per acre in 1951-52, the tenth year after planting.

Yield of Crossed and Selfed Progeny of a Nigerian Selection and Trinidad Seedling

	Variety	*Yield lbs per acre*	*Remarks*
	Nigerian-Trinidadian Hybrids		
G	T38×Ta	1,335	
J	T38×Tc	1,312	
H	T38×Tb	999	The difference to be significant must exceed 318 at level of P=0.01 or 242 when P=0.05.
	Nigerian Parent selfed		
D	T38 selfed (F1)	723	
E	F1 of T38 selfed (F2)	495	
F	F1 of T38 selfed (F2)	324	
	Trinidadian Parents selfed		
C	Tc selfed	525	
B	Tb selfed	506	
A	Ta selfed	321	

In these figures the hybrid progeny show a much greater yield than the progeny of the parents selfed. Moreover the seed of T38 selfed for two generations shows a significantly lower yield than T38 selfed once. These results suggest a loss of vigour following inbreeding and an increase in vigour when two widely different kinds of cocoa are crossed. Samples of the beans from hybrids sent to the Cocoa Assessment Panel in London for evaluation were well received and were considered to have the characters looked for in West African Cocoa.

The spacing-trial planted in 1942 continued to give interesting results. In previous years highest yields per acre had been given at first by the closest spacing (5 by 5 feet) and then by the next closest (6 by 6 feet). In 1951-52, the tenth year after planting, the third closest spacing (6 by 7½ feet) gave the greatest yield, though there was no great significance between yields of the four closest spacings. It is apparent therefore that the advantage held by the very close plantings is soon lost.

Fermentation tests of beans from pods at different stages of maturity were made in co-operation with the Department of Marketing and Exports to see if the presence of undesirable purple beans in the fermented sample was due to the harvesting of unripe pods. It was found that more purple beans occurred in samples from under-ripe pods than in samples from mature or over-ripe pods, but that the length of the period of fermentation had a greater effect than the degree of ripeness of the pod. Pods left on the ground for two and for four days after harvesting and before removal of the beans for fermenting gave a poorer fermented sample than was obtained when fermentation was begun immediately after harvesting.

Planting material of the Nigerian selection T38 and of picked Amelonado trees from the Botanist's plots was supplied to the Cocoa Division in the Western Provinces and also to the Eastern Region for planting in Ogoja Province and the Cameroons.

Citrus

Although sour orange has continued to give good results as a stock for orange and grapefruit in the Western Provinces, the desirability of continuing its use has been questioned in view of its susceptibility to "tristeza" disease in other citrus-growing countries. This disease has not yet been observed in Nigeria but is present elsewhere in West Africa and may therefore not be long delayed in finding its way to this country. While most of the departmental nurseries in the West have now turned to sweet orange, this has a serious disadvantage in its susceptibility to gummosis which commonly attacks the trees and may shorten their life. Trials are being made of other kinds of citrus as rootstocks and Cleopatra tangerine seems promising at this early stage. Sampson tangelo may also prove useful though, like sour orange, it suffers heavily from scab in the nursery in wet weather, and is rather slower in making growth and in being fit for budding.

With the co-operation of the Chemistry Section juice analyses of lemons have been made fortnightly for the past two years and have given satisfactory results for quantity and quality of juice in the varieties Lisbon, Eureka, Villafranca, and Genoa. These ripen on the trees over a long season under Nigerian conditions and the citric acid content is well maintained throughout the year.

Cotton

The decision to discontinue the multiplication and distribution of the Improved Ishan variety of cotton to farmers in the Western Provinces closes a chapter in the records of the Botany Section. This cotton, a form of *Gossypium barbadense*, arose from a collection made by C. J. Lewin in 1924 from farmers' plots in Ishan Division of Benin Province during his search for a cotton adapted to conditions in Southern Nigeria and suitable for export. After some years' selection at Moor Plantation a strain known as Ishan 'A' was selected as highly resistant to leaf-curl in the field and giving cotton of good staple-length and exceptional strength of lint. Its chief defect was a certain roughness of the fibre. An attempt to eliminate this by breeding with a smooth variety and back-crossing with Ishan was started but was abandoned during the war and not resumed.

A scheme of multiplication was adopted in order to provide seed of Ishan 'A' for farmers in Oyo and Abeokuta Provinces. The stock was maintained by the Botanist, selection for lint-length and yield being continued within the population. Each year's selection was multiplied for two years on Moor Plantation and then for two years in the Meko Division of Abeokuta Province whence other varieties of cotton were excluded. Seed was distributed in the fifth season and the aim was to provide 250,000 lbs. This scheme proceeded rather haltingly as a result chiefly of poor yields on Moor Plantation through heavy attack of the capsid, Helopeltis, and bollworm. An answer to these pests was found in the last season when satisfactory control was obtained in the Botanist's plots by several sprayings with a 5 per cent suspension of DDT in water. The yield of 470 lbs seed cotton per acre in the multiplication plot was the best for some years.

The distribution of Ishan seed has now been abandoned because no export of cotton has resulted. In the south nearly all the cotton produced has been used for domestic spinning for which the unimproved local cotton is equally satisfactory. To produce a high-quality cotton for this purpose at some expense has been shown to be a misdirected effort.

OTHER FOOD-CROPS

A collection of legumes which includes several species of possible value was maintained and studied. Particular attention was given to local selections of *Phaseolus lunatus*, some varieties of which under the name Butter Beans are in considerable demand for export to Europe as well as being of use locally. Varietal collections of yams, sweet potatoes, and other minor crops were maintained.

FOOD-CROPS AT UMUAHIA—T. A. Russell

A very useful collection of local yams obtained from farmers' plots throughout the Region has been brought together at Umudike. The edible yams of Nigeria belong to several species of *Dioscorea* and within some of these species the farmers recognise many different kinds which are known by vernacular names and distinguished by habit of growth and by quality of the tubers. The Assistant has made progress in sorting the collection into groups with a view to later botanical study and the selection of outstanding kinds.

High yields of cassava were obtained in a varietal trial. On account of a large plot error no great significance could be placed on the differences in yields between varieties. Nevertheless it was of interest to find the local variety Karagba and the Gold Coast hybrid 997B in the first two places as in the corresponding trial at Ibadan. Some success has been obtained in keeping isolated blocks of cassava free from mosaic by continual inspection and removal of diseased plants. This is being tried to see if it is a practical method of producing clean material suitable for planting. A trial has now been laid down to see if clean cuttings so produced give higher yields than cuttings already infected with mosaic at the time of planting.

In a trial of cowpea varieties the local kinds were surpassed in yield by earlier maturing introduced varieties, as also occurred at Ibadan.

MISCELLANEOUS

Studies have been continued on the edible species of *Cola* in use in Nigeria with special emphasis on the productivity of *Cola nitida* the common kolanut of commerce. Interest is also being taken in rubber and a collection of some useful clones is being made.

PLANT EXCHANGE

The Botanist at Ibadan continued to be responsible for the introduction and quarantine of plants from other countries required for the work of the Department. In furtherance of work on maize rust, samples of maize were brought in from a wide range of countries; United States of America, Canada, Venezuela, Mexico, Australia, South Africa, Kenya, Uganda, and Sierra Leone. Other plants introduced included varieties of guinea-corn or sorghum from United States and Southern Rhodesia, Sugar-cane varieties from South Africa, mulberry (*Morus alba*) from Cyprus, quick-growing leguminous shade-plants from Ceylon, and grasses from South Africa. Thanks are due to the Department of Agriculture and other institutions in these countries by whom these materials were supplied. Rubber seed from South America desired by United Africa Company Limited for experimental work was germinated at Royal Botanic Gardens, Kew, under suitable quarantine conditions and was grown for a further period of quarantine in the greenhouses at Moor Plantation.

Many requests from other countries for the supply of planting-material were handed through the Botanist's Office. This work of plant exchange increases yearly and additional staff and facilities for fumigation and quarantine are necessary if it is to be efficiently done.

PLANT PATHOLOGY SECTION

Investigations on the life history and control of cacao "black-pod" continued to occupy the full-time services of a Plant Pathologist. During the year under review several important diseases called for investigation, particularly maize rust, *Puccinia polysora* in the Southern Regions and Red Rot of Sugar-cane, *Colletotrichum falcatum* in the Northern Region. The establishment of the Maize Rust Research Scheme will take care of the first problem but an additional Plant Pathologist will be required to deal with the second one. A list of diseases recorded follows the account of the work performed on "black-pod" of cacao.

INVESTIGATIONS ON BLACK-POD DISEASE OF CACAO—C. A. THOROLD

In these investigations, particular attention has been given to the dispersal of the fungus and to large-scale control measures.

There is now abundant evidence that black-pod disease must be regarded as an air-borne disease, comparable in this respect with potato blight (*P. infestans*). It is evident that much infection is the result of contact between diseased and healthy pods, whilst some infection results from drops of water carrying sporangia or zoospores over short distances. Nevertheless, neither contact nor such water dispersal account for all the observed facts of black-pod incidence. Rain drops are likely to play an important part, as with other air-borne diseases, in so far as they may 'wash' sporangia out of the air. Sporangia have been trapped on small cellophane discs placed over pod spots where *Phytophthora palmivora* is fructifying.

It is probable that convection currents play an important part in the distribution of sporangia. There is much air turbulence near the ground, so that the necessary conditions occur for both vertical and horizontal dispersion of sporangia.

Observations were made at Ina and at Agodi on numbers of affected pods at distances up to about fifty yards from a central tree. Black-pods were allowed to remain on the central tree and infected pods were heaped around its base so that it should approximate to a 'point-source'. Black-pods were recorded and removed every other day from all the trees in the observation area except for the central tree. It was found that over the range 0-50 metres, the incidence of *P. palmivora* infection agreed well with that for *P. infestans* and is in general conformity with air-borne dispersal in conditions of moderate air turbulence.

It is to be noted that in these experiments, infection must have come either from the central tree, or from outside of the area, or from both sources. Under these conditions, a gradient of infection from the point-source was evident over the range 0-50 metres, but beyond this distance another gradient from the adjacent uncontrolled trees was superimposed on the first one. Under field conditions, there are generally a number of affected trees, all serving as foci of infection, in addition to wide-spread infection from more distant trees. Therefore, it is not unexpected that the incidence of affected trees in a cacao field is generally intermediate between that which would be expected for an infectious disease on the one hand, and for air-borne disease on the other. The implications of these findings are that for the control of the disease, precautions must be taken against both short distance and long distance infections.

CONTROL BY BLACK-POD REMOVAL

Observations on the development of pod spotting, following artificial inoculations, have shown that there is generally a period of two days during which there are visible symptoms before sporangia production starts. It is a general rule that fructification begins in the evening of the second day or the early morning hours of the third day. Accordingly, it should be possible to remove diseased pods before sporangia production starts, if trees are inspected every other day. If a longer period elapses between inspection rounds, sporangia production is likely to start before the pod is removed. It has been found that sporangia produced at the time when fructification begins (as observed microscopically) can cause infection, therefore, it is important that affected pods should be removed before fructification starts, otherwise further infection may occur. There is evidence from field experiments that inspection of trees every other day for removal of black-pods prevents the build-up of infection. The success of the method depends on the absence of infection from neighbouring untreated trees.

Observations are now being made at Agodi Cocoa Farm, to determine the distance of spread of *Phytophthora palmivora*. It cannot be foreseen whether sufficiently definite results will be obtained there, or whether further observations on a larger area of cacao may be necessary. It is important that reliable information should be available, because it will be valuable to know the distance which should intervene between cacao farms, such that infection may not spread from one farm to the other. Such information will be required for delimiting groups of farms constituting isolated units of cacao, for the application of control measures on a large-scale.

Relation of Incidence of Black-pod and spacing of Trees to Control Measures

In order that control by frequent inspection and removal of black-pods may be a satisfactory control measure, it is important that possible sources of infection should be minimised. One objective in this respect will be a high proportion of trees with a few or no black-pods; this may be considered as a major aim of black-pod control, second only in importance to increase in percentage of healthy pods. The following Table shows that trees with few pods tend also to be "healthy" trees (that is, trees with no black-pods).

Table 1.—Tabulation of fifty trees from a total population of 298 trees considered on a farm near Ife, classified according to number of total pods per tree (1, 5, 10, 15, 20) and number of black-pods per tree observed (o), and expected (e). Observations made on 10th July, 1950, when the average number of pods per tree was 16.2 and black-pod 51.7 per cent.

No. pods per tree	1		5		10		15		20	
No. of black-pods per tree	*o*	*e*	*o*	*e*	*o*	*e*	*o*	*e*	*o*	*e*
0	4	4.0	***2**	**0.4**	***4**	**0.1**	***2**	**0.0**	0	0.0
1	2	2.0	2	1.7	1	0.5	1	0.1	0	0.0
2			1	2.7	0	1.5	1	0.4	0	0.0
3			0	2.2	2	3.0	0	0.9	0	0.0
4			1	1.0	0	x3.7	2	1.6	0	0.0
5			****2**	**0.0**	3	x3.2	0	2.1	0	0.0
6					2	x2.0	0	2.0	1	0.0
7					0	0.8	0	1.5	0	0.1
8					0	0.2	0	0.9	2	0.3
9					1	0.0	1	0.4	0	0.6
10					****2**	**0.0**	1	0.1	0	1.1
11							0	0.0	2	1.6
12							1	0.0	0	2.0
13							****1**	**0.0**	1	1.9
14									2	1.6
15									1	1.0
16									1	0.5
17									0	0.2
18									0	0.1
19									0	0.0
20									****1**	**0.0**
Total trees ...	6	6.0	8	8.0	15	15.0	10	10.0	11	11.0

N.B.—Trees with intermediate numbers of pods, *viz.*, 2-4, 6-9, 11-14, 16-19, 21-omitted.

On theoretical grounds, it is to be expected that numbers of diseased pods will vary according to numbers of uninfected pods available. When healthy and diseased pods have been recorded for a sufficiently large number of trees, it is possible to calculate the numbers of infected pods to be expected if infection spreads uniformly amongst the observed trees. It is found that there is reasonably good agreement with theory; although observed and expected numbers differ somewhat, they are of similar order. The divergence between observation and theory are of importance in connection with possible control measures. These comparisons can be conveniently illustrated by a summary tabulation of one group of trees for which the expected numbers of black-pods have been determined. The important comparisons are in black type in the table, and are as follows:—

(*a*) There is a tendency for numbers to exceed expectation in cases of trees with no black-pods (*).

(*b*) Observed numbers of trees in which all, or nearly all the pods are affected, exceed expected numbers (**). This feature alone may apply in cases of trees with relatively large numbers of pods (20 and over).

In addition, the Table shows that trees with few pods tend also to be "healthy" trees, *i.e.*, trees with no black-pods and confirmation of this relationship was found in the course of the black-pod survey carried out in 1950.

The relevant information with respect to ten farms is summarised in the Table 2 below. The farms are arranged in order of increasing black-pod incidence (1% to 34%), whilst the average yields varied from eight to twenty-nine pods per tree.

Table 2.—Showing percentages of healthy trees (observed and expected) at varying yields and incidence of black-pod disease.

Black-pods (percent of total pods)		*Average yield (mean no total pods per tree)*	*"Healthy" trees (percent of total trees)*	
			Observed	*Expected*
Farm	%			
1	1	25	93.4	86.9
2	2	8	88.8	86.4
3	7	13	58.2	46.5
4	8	19	58.2	47.6
5	13	28	22.1	12.3
6	17	14	49.1	29.4
7	23	17	28.2	13.9
8	23	29	10.5	3.4
9	33	11	40.7	24.3
10	34	19	24.3	13.2

The above table shows that the percentage of healthy trees tends to decrease with increasing incidence of black-pod, as would be expected. When certain pairs of farms having similar black-pod percentages are considered (7 and 8, 23 per cent ; 9 and 10, 33 per cent and 34 per cent) it will be noted that the percentage of healthy trees is greater when yields are relatively small and conversely. The observed proportion of healthy trees is in all cases greater than the proportion expected, thereby confirming the conclusions drawn from the previous table.

There is evidence that the advantage of small yields per tree for black-pod control is compatible with relatively high yields per acre. Yields and incidence of black-pod disease have been under comparison at three different spacings (8′ × 8′ ; 12′ × 12′ ; 15′ × 15′) at Ina since 1945-46. The treatment comparison is based on acre plots in the cases of the different spacings, the plots, therefore, comprise different stands (675, 300, 192 respectively). The three spacings are now compared on the basis of 7-year averages, as numbers of pods and numbers of black-pods per acre (Table 3) and per tree (Table 4).

Table 3.—Yields and incidence of black-pod as mean numbers of pods per plot.

Spacing	*Healthy pods*	*Black-pods*	*Total Pods*	*Black-pod*
				%
8′ × 8′	2,589.9	1,321.7	3,911.6	34
12′ × 12′	1,863.3	719.7	2,583.0	28
15′ × 15′	1,685.5	563.4	2,248.9	25

Table 3 shows that the closest spacing (8′ × 8′) has given the highest yield of healthy pods on the acre basis, although the percentage of black-pod is greater at 8′ × 8′, compared with 12′ × 12′ and with 15′ × 15′. However, when yields per tree are considered (Table 4), the trends are seen to be the reverse of those in Table 3 although percentage losses remain the same.

Table 4.—Yields and incidence of black-pod as mean numbers of pods per tree.

Spacing	*Healthy pods*	*Black-pods*	*Total pods*	*Black-pod*
				%
8′ × 8′	3.84	1.96	5.80	34
12′ × 12′	6.21	2.40	8.61	28
15′ × 15′	8.78	2.93	11.71	25

These results indicate that a relatively close spacing (8′ × 8′) may be advantageous both with respect to number of black-pod per tree (Table 4) but particularly with a view to obtaining maximum yield per acre (Table 3). It is appreciated that a number of considerations, other than that of black-pod control, are involved in deciding on the proper spacing for cacao under various conditions. However, the position may be summarised as follows, with respect to black-pod control :—

It is desirable that there should be relatively few pods per tree when control by removal of affected pods is intended. There is a greater likelihood of trees with no black-pods when yields are small, in this way chances of infection are minimised.

Close spacings tend towards small yields per tree but with relatively large yields per acre.

Wide spacings, with the expectation of relatively large numbers of pods per tree, are not desirable unless control by spacing is intended. Otherwise, many black-pods may have to be removed. There will be more opportunities for infection if black-pods are overlooked when sporangia production begins.

There is no evidence that the incidence of black-pod disease is directly affected by spacing under conditions in Nigeria. The apparent relationship between spacing and black-pod incidence can be adequately explained on the basis of average tree yields at different spacings. These conclusions are important, because it has previously been supposed that fields should be planted at a wide spacing, or trees manipulated to that effect for black-pod control. It seems that this supposition is not supported by the facts in Nigeria and that ordinary air conditions locally are generally favourable for spread of black-pod at certain times of the year. Therefore, within the range of practicable spacings (say 6′ × 6′ upwards), the eco-climate is not appreciably affected with respect to conditions being favourable or otherwise, for black-pod, because even at an infinitely wide spacing (an isolated tree), black-pod disease can be severe. It seems that such differences as may occur between the climates of fields at different spacings are relatively unimportant in comparison with other factors, such as number of pods available and amount of infection present.

Control by Application of Fungicide

Somewhat different considerations apply when black-pod control by spraying can be done. It will be shown later, that spraying is unlikely to be profitable when yields are small.

It may not be economical for a few high-yielding trees to carry the cost of too many low-yielders. However, there may even be a limitation regarding the yield per tree which is desirable, in so far as trees with very large numbers of pods may also tend to be very large trees. Large trees may be unsuitable for application of fungicide because pods high up in the canopy are difficult to spray. A branch system with many ramifications may be undesirable for this reason, because the pods tend to be hidden in the canopy. In the course of spraying experiments at Owena, it has been found that high pods (at 7′ from the ground and over) tend to be the ones which are infected in spite of spraying, as shown in the table below :—

Table 5.—Percentages of healthy and diseased pods, both classified as "high" (7' and over) and "low" (below 7') recorded for sprayed and untreated trees at Owena.

	Sprayed Trees		Untreated Trees		
	Black-pods	*Healthy pods*	*Black-pods*	*Healthy pods*	*Total*
High pods	9.8	16.9	8.5	4.4	39.6
Low pods	3.3	39.6	10.5	7.0	60.4
Total	13.1	56.5	19.0	11.4	100.0

The table shows that there were relatively more high black-pods (9.8%) than low black-pods (3.3%) in the case of the sprayed trees, whilst in the untreated trees, the percentages of high black-pods (8.5) and low black-pods (10.5) are similar. Therefore, spraying has been relatively more efficient in protecting low pods, than it has been protecting high pods from infection. These results indicate that trees with pods on the trunk will be more suitable for spraying than trees with much canopy crop. This suggests that when spraying is contemplated, it is desirable that trees should not be so widely spaced as to encourage a low-branching habit, apart from this consideration, it is desirable that trees should carry the maximum number of pods in order to make spraying a profitable procedure.

In August 1951, I visited Fernando Po on behalf of the Government of Nigeria, during the period 4th August to 28th August. On account of the excellent arrangements made for me by the Director of Agriculture, Senor Don Pedro Grajera, I was able to obtain valuable information on fungicide spraying for control of black-pod disease.

Spraying is almost universal on cacao properties in Fernando Po. Copper sulphate is used in combination with quicklime to give a 2 per cent Bordeaux mixture. The number of applications of this fungicide varies from two to four.

There is now an annual importation of about two thousand tons of copper sulphate for application to cacao in Fernando Po (an additional amount is imported for application to coffee). It appears that cocoa production is in direct proportion to copper sulphate consumption. About one ton of copper sulphate is used for every ten tons of cocoa produced.

Small-scale experiments at Owena have shown that applications of 1 per cent Carbide Bordeaux mixture at intervals of three weeks between applications, can reduce the incidence of black-pod disease. There was a loss of at least 50 per cent of the pods from black-pod disease on untreated trees at Owena as compared with a loss of about 10 per cent of the pods on the sprayed trees. It was found that the pods which were affected, in spite of spraying, were mainly those which were at such a distance from the ground that fungicide was not effectively applied with the hand pumps employed.

Through the kind assistance of the Registrar of Co-operative Societies, arrangements have been made for large-scale testing of control measures on a group of farms in Ondo Province. These farms have been generously loaned by members of the Apomu-Akure Co-operative Society, and comprise an area of about sixty acres, which is divided into portions for observations on control of spraying and by removal of infected pods respectively. There is also an untreated area for comparison.

A detailed account is kept of expenditure in connection with these experiments, so that the cost of control measures can be assessed at the end of the season, together with information on the numbers of healthy and diseased pods in the areas subjected to different treatments.

NOTES ON PLANT DISEASES—J. M. Waterston

* Denotes new record for Nigeria.

Cacao

Two diseases of cacao occur in the Cameroons which are causing some concern. Their origin is yet unknown but they have been named "Chlorosis" and "Leafless twig" disease.

Chlorosis.—During the course of a preliminary survey of the Cameroons area by the Cocoa Division in November 1947 to January 1948, several farms were found to be affected with a curious leaf disease. A re-survey of the area three years later revealed that the disease had spread over an area of 120 square miles. In view of this somewhat alarming picture, the writer paid a visit to Kumba in July 1951, to formulate measures for a disease census and to secure grafting material for further transmission studies.

The leaves from trees affected with this disease show necrotic symptoms of which Chloronemia or clearing of the leaf tissue near the secondary veins of the leaves is the most conspicuous symptom, distinguishing it from Posnette's Trinidad vein clearing disease which affects all of the veins. In the early stages, the clearing may be observed to start from the margin of the leaves and progress inwards in the area between the primary veins. The latter are not affected by the disease which is restricted to the area adjacent to the secondary and tertiary veins. No other symptoms such as mosaic, mottle or leaf spot are present.

In advanced stages of the disease, the leaves are reduced in size, the yellowing of the inter-veinal tissues becomes more pronounced, the margin of the affected leaves curve inwards and the surface becomes crinkled. Leaf scorch on the margins of the affected leaves may also be present.

When the young flush of the affected trees is examined no symptoms are observed on the first few leaves showing deep red pigment. As this fades to the pale pink stage in the older leaves, symptoms of tissue clearing appear quite distinctly working inwards from the margin. These, however, may disappear on the older leaves on the same shoot.

No swellings were seen on the shoots of affected trees and the pods appeared normal in shape and size. Attempts to transmit this disease by budding and veneer grafting, as well, as by using mealybugs, *Pseudococcus citri* and *Ferrisiana virgata* fed on foliage and pods of affected trees and transferred to receptor cacao beans have been negative to date, but further plans are being made to carry out this work on the spot in the Cameroons. The possibility of a nutritional deficiency being involved will also be investigated although this appears remote on the volcanic soils of the Kumba area.

Leafless Twig Disease.—This disease is characterised by the production of large numbers of leafless twigs, with greatly reduced internodes, accompanied by an abnormal development of dormant axillary buds leading to the formation of multiple shoots. The leafless condition is brought about through abcission of the buds formed in the apical region of the shoot at a very early age. The leaf stipules continue to persist for a time, clustered together at the end of the shoot and producing a characteristic "paint brush" appearance.

Leafless chupons may also be produced with the "paint brush" symptoms and which also show uni-lateral swellings. These differ from the swellings typical of swollen shoot, which are generally symmetrical and from lesions caused by capsids.

Viewed from a distance, the crown of the diseased tree bears a superficial resemblance to die-back. Close inspection however, reveals that the leafless twigs scattered in the periphery of the canopy are still alive and not dead as in the latter disease.

The disease was first described from the Cameroons in 1907 by von Faber from material collected at the Bibundi and Isongo Plantations by the German Plant Pathological Expedition to West Africa (Busse, 1905, 1906). von Faber attributed the disease to a fungus, *Taphrina bussei*. Twenty-nine years later, the disease was again reported from Ekona Plantation in the Cameroons by Ludwigs (1934) who attributed the condition to adverse physiological

Busse (1905) Der Tropenpflanzer *9* : 25-37 : 169-184 : 247-258.
Busse (1907) Beihefte zum Tropenpflanzer *7* : nr. 415.
Ludwigs (1934) Der Tropenpflanzer *37* : 198-203.

growth factors rather than to a pathogen. The writer is in agreement with this view and believes that the disease may be associated with light relationships especially where cacao is inadequately shaded and is subject to frequent flushing. The condition has also been found in Nigeria but never in such a severe form as in the Cameroons.

Citrus

The discovery of the presence of *Aphis citricidus* at Moor Plantation, Ibadan—the insect vector of "Tristeza" disease of citrus causing widespread damage in the Gold Coast and South Africa—was viewed with some alarm as most of the citrus in the Southern Region is budded on sour orange which is a susceptible rootstock. Arrangements were made for Dr Waterston to visit the Gold Coast, 11th to 20th June, 1951 to study at first hand the effects of the disease on the citrus industry. As a result of this visit the citrus rootstock policy has been revised and research is being carried out to discover suitable substitutes for sour orange as a precaution against the entry of the virus into Nigeria at some future date from neighbouring territory.

New host records for Nigeria were obtained by the discovery of **Ganoderma lucidum* attacking senescent lime trees, and **Ustulina zonata* on sour orange, sweet orange, grapefruit and lime rootstocks.

Coconuts

A coconut disease of undetermined origin appeared in Awgu Division around December 1951, which resembled a similar outbreak in Onitsha Province in 1917*. The area was visited by Mr Malcolm Park, Director of Agriculture, Eastern Region, in January 1952 who reported the symptoms were those of a wilt disease. The oldest leaves were affected first, losing their healthy green colour and becoming irregularly mottled and later brown and dry. The discolouration progressively affected the younger leaves until in extreme cases the whole crown died.

Local people claimed that the disease was checked if a hole 2 to 3 inches square was cut through the trunk. Mr Park informs the writer that this treatment was used and thought to be effective in Ceylon against lightning strike.

Gum production from the stem of affected trees was seen near ground level but the discolouration of the trunk was not extensive beneath this exudation. There was no sign of extensive attack by *Ganoderma lucidum*.

Coffee

Leaf disease **Hemileia vastatrix* was observed by C. A. Thorold, at Bamenda, British Cameroons on the leaves of *Coffea arabica*. The material (No. IMI. 49981) was determined by Dr G. R. Bisby of the Commonwealth Mycological Institute as typical. A species of *Titaea* which may be a parasite of the rust was also present. A different species *H. coffeicola* Maubl. & Roger has been found attacking coffee in the French Cameroons. Commenting on this Dr Bisby states "Although *H. Coffeicola* Maubl. & Roger seemed to be a distinct species when described in 1934, uredinologists now think it may have been only a form or abnormality of *H. Vastatrix*. Further collections from the Nigeria region may solve that problem".

*"*Black Tip*" or "Hot and Cold" disease was also diagnosed by C. A. Thorold on specimens of Arabica coffee collected at Bambui upper farm, British Cameroons. This is a non-parasitic disease more prevalent at the higher altitudes (6,000 feet and upwards) than at the lower. The extremities of the branches are killed and turn black ; a few leaves are similarly affected, and the remainder near the tips are crinkled and pinched and have an unhealthy yellowish tinge. Considerable bunching of the secondary and tertiary branches occurs, due to their profuse production following the death of the apical growing points. The disease is associated with too rapid diurnal fluctuations in temperature and is particularly noticeable where coffee has been planted low down on the slopes of valleys in situations where cold air collects after sunset.

* Annual Report, Agricultural Department, Southern Provinces, Nigeria, for the year 1917, paragraphs 71-72 ; *Ibid*, 1918, paragraph 66.

Most cases of "Black Tip" disappear on the provision of suitable shade, which reduces the rate of change of temperature in the plantation, and permits adequate photosynthesis. This is important as carbon assimilation in Arabica coffee is suppressed when the leaves are subjected to full sunlight.

Guineacorn

The following diseases were noted by Dr O. J. Webster during the course of his studies of sorghum breeding in the Northern Region. The leaf diseases were mostly bacterial. Zonate leaf spot, *Gloeocercospora sorghi* was found in all fields but on a few leaves. Sorghum rust **Puccinia purpurea* was found only in trace amounts. Head smut, *Sorosporium reilianum* was observed in the test plots at Ganawuri.

There was generally a high incidence of Kernel smut, *Sphacelotheca sorghi*, particularly on the rocky escarpment between Pankshin and Langtang where about 25 per cent of the heads were smutted. Dr Webster has suggested that it would be a worthwhile project to make available non-toxic fungicides to the sorghum farmers in small packets with simple instructions for use.

Maize

No mycological studies on rust disease, *Puccinia polysora*, were possible owing to shortage of qualified staff. It is hoped that this will be remedied soon with the appointment of the team of investigators under the Colonial Development and Welfare Maize Rust Research West Africa Scheme.

Rice

False smut of paddy **Ustilaginoidea virens* was severe at Massagha Swamp, Calabar Province but not of such intensity as observed in the previous year at this site. Instructions had been issued to select seed from areas of nil or light infection only, but it is not known whether this was an important factor in reducing the incidence of the disease. The disease was also reported on paddy at Itu on the Enyong Creek and at Adani, Onitsha Province in 1951.

This is the first record of the disease from Nigeria, although it has previously been recorded from Liberia and Sierra Leone, in West Africa. No satisfactory control measure has been devised against the disease, which is said rarely to cause damage in rice growing areas throughout the world. The factors causing it to occasionally develop in epiphytotic form are not understood.

Sugar-cane

A serious outbreak of disease in sugar-cane fields was first observed in October 1951 in two small swamps, Ehir fadama and Damba fadama near the village of Muzuru in the Yabo District, Sokoto. The disease was later reported over a wide area in the Northern Region ranging from Sokoto to Daudawa, Makarfi and Maigana. Inspection of both recently planted and mature sugar-cane eighteen months old, revealed the disease to be Red Rot, caused by **Colletotrichum falcatum*. This disease is apparently new to Nigeria as cane farmers of forty years experience in Zaria Province say that the trouble was unobserved up to the year 1950.

The pathogen was isolated by the writer in pure culture, and proves to be light in colour, similar to the strain which caused heavy losses to the white sugar belt in North India in 1938 to 1941.

A common symptom of the disease in Nigeria is the drying up of the middle portions of the canes indicating that the most common source of infection in this epidemic appears to be aerial, with the pathogen working downwards in the stem. These observations confirm those of Watts Padwick and Chona (1950) who stress the part played by air-borne

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Watts Padwick and Chona (1950) Indian Journ. Agric. Sci. *20* : 363-385.

secondary infections of the upper, younger nodes of the canes. Infection of the cut ends of young sets in contact with the soil also occurs in Nigeria. The sudden appearance of such a potentially virulent disease as red rot in Nigeria, simultaneously over a wide area is difficult to explain. We can only postulate that the disease has been present in the territory for some time and has suddenly assumed epidemic proportions due to change of virulence through saltation. The type of sugar-cane grown is a local soft one, used mainly for chewing, and very large quantities are consumed raw. In addition, some 60,000 tons are crushed annually for the manufacture of brown molasses sugar.

Steps are being taken to introduce material of red rot resistant varieties from the leading sugar-cane breeding stations in Africa, India and the West Indies, and research on control measures will also be undertaken.

The following named varieties are established at Maigana and up to the present show no symptoms of the disease : Co. 213, Co. 301, Co. 331 and Uba. It is hoped that they will produce sufficient planting material for a full scale variety trial in 1953.

ENTOMOLOGY SECTION

STAFF

J. R. G. Sutherland	*Senior Entomologist*
J. T. Davey	*Entomologist*
J. L. Gregory	*Entomologist*
A. F. H. Baillie	*Cotton Entomologist (E.C.G.C.)*

The major problems investigated by the Entomological section included a survey of stem-borers of graminaceous crops in the Northern Region, a study of the control of beetles attacking yams in the Eastern Region, and investigations on the control of major cocoa pests in the Western Region.

STUDIES OF THE ECOLOGY OF THE AFRICAN MIGRATORY LOCUST—J. T. Davey

The routine annual Migratory Locust Patrol to the Lake Chad area took place between 25th November and 15th December, 1951. Neither adults nor hoppers were observed during this brief period, nor has either been reported since by Locust Scouts on Local patrol.

In late October, Mr J. T. Davey was seconded for seven months to C.I.P.P.A.S., the provisional international body for the control of the Migratory Locust in the French Sudan, as a leader of a mission charged with the study of locust ecology in that area.

SURVEY OF STEM-BORERS OF GRAMINACEOUS CROPS—J. R. G. Sutherland

A reconnaissance survey of stem-borers of graminaceous crops, carried out in four provinces of Northern Region was made in September 1951. During the remainder of the year the first steps were taken toward the eventual development of a general census of damage by grain crop pests throughout Nigeria, and the possibility of their effective control. While the emphasis remained on stem-borers, records were taken and collections made of any insects which appeared to be of real or potential danger to economic plants.

By mid-December, the area lying to the north of a line Birnin Kebi-Mokwa-Yola had been covered, records having been taken at intervals of about twenty miles along all motorable roads, save in the vicinity of Lake Chad, where animal transport was used and observations confined to the *firki*.

Although the data regarding stem-borer infestations by species and hosts have not yet been thoroughly analysed for lack of some identifications, it can be said that representatives of at least five known and two undetermined genera have been found attacking graminaceous crops in the eight provinces visited in the course of this survey. Of these, *Busseola fusca* appears to have the widest distribution, though it seems to be largely replaced by *Proceras* spp. in the millet area which stretches as a belt across the north of the Territory.

The figures in Tables 6 and 7 show that there is a fairly high incidence of borer attack in all the major cereal crops and sugar-cane, and particularly in guinea-corn and millet, the two staple food-crops of the North. However, the data collected up to now are insufficient to permit assessment of the true situation regarding these insects. Certain conclusions may be drawn : the attack rates are all higher than those of the European Corn Borer in New York State in 1925, reported by Caffrey (1929), where it was considered a major pest and a complete organisation was set up to deal with it ; many of the borers involved have not been determined : two of the genera are widely distributed and appear to have adapted themselves to all but rice and sugar-cane ; a certain amount of preference by species seems to occur among crops in each vegetation Zone covered by this survey.

This situation is somewhat unexpected, for it has been stated that *Proceras* replaces *Busseola* in the coastal regions of East Africa, and *Sesamia* spp. replace *Busseola* in West Africa, Jepson (1951). On the other hand, Bowden has found (personal communication) that *Proceras* is the predominant genus in the millet-growing areas of the Gold Coast, though he expected a considerable replacement of *Busseola* by *Sesamia* in the sorghum areas of Nigeria.

Total stem-borer attack rates by crops are given in Table 6. Table 7 gives the infestation rates by crops and vegetation zones.

Table 6.—Provisional percentage rates of Stem-Borer attack on Crops in eight Provinces of Northern Region.

	No. of samples	*Minimum rate per cent*	*Maximum rate per cent*	*Mean rate per cent*
Guinea Corn	63	2	78	32.87
Maize	4	6	25	13.25
Rice	11	8	31	16.45
Millet	76	5	64	31.22

It has not yet been possible to form any accurate estimate of the relationship between attack rate and the economic loss involved. This must vary by species of borer and variety of crop attacked. Badly lodged stands of tall guinea-corn (farafara) have been seen with borer incidence of over 70 per cent, in which the yield was estimated at about 300 lbs per acre. Two stands of short kaura were seen with infestations of over 50 per cent, without any lodging, and a statistical study of one of them showed no conclusive evidence of the effect of borer attack on yield.

Various methods of control have been tried in the past against stem-borers of cereals. Generalisation in this field is often more misleading than usual, because of the varying habits even of a single species under only slightly different conditions of climate, weather, host-availability and crop hygiene.

Cultural control measures have usually proved to be the most practicable method against this type of borer in other countries. In the United States, after years of introducing large numbers of several species of parasites of the European Corn Borer, at least one species has recently shown signs of effectively controlling the pest under certain conditions.

Some degree of success has been claimed recently for chemical control measures in East Africa, Jepson (1951). During routine protection against *Busseola fusca* in maize multiplication plots at Ibadan in 1951, a considerable difference was observed in thriftiness of plants in treated and untreated plots. After delaying treatment for three weeks, the plots previously untreated were dosed with 3.33 per cent D.D.T. in suspension, in the same way as had been done for the other groups. The only two 1.32 acre plots of these groups which were comparable showed yields of 686 lbs and 811 lbs respectively, an increase of 125 lbs in the case of the plot treated at knee height over that treated at breast height. The cost of this treatment was approximately £1 per acre.

STUDIES OF THE TAXONOMY, BIOLOGY AND CONTROL OF BEETLES ATTACKING YAMS—J. L. Gregory

The results of the yam beetle control experiments at Kwale and Ekwulobia were disappointing. They were designed to test the effect of two B.H.C. and two D.D.T. formulations on the damage caused by yam beetle and upon the palatability of the yams. In the Ekwulobia experiment, where planting was unavoidably late overall yields were very poor and yam beetle attack rate low.

Caffrey (1929). J. Econ. Ent. *22* : 169.
Jepson (1951). Plant. Prot. Overseas Rev. *2* : 2 : 16, 17.

Table 7.—Preliminary Survey of Stem Borers of Gramineae by Vegetation Zones : Genera, Host Plants and Number of Borers each Hundred Plants for each Locality

Hoses	*No. of Localities*	SAHEL ZONE							*No. of Localities*	SUDAN ZONE							*No of Localities*	NORTHERN GUINEA ZONE							*Mean Percentage rate of infestation*
		P	B	S	E	Rh	O	*Totals*		P	B	S	E	Rh	O	*Totals*		P	B	S	E	Rh	O	*Totals*	
Guinea Corn	4	—	8	4	—	—	21	23	48	20	42	9	40	—	1,024	1,322	20	11	157	10	11	—	598	787	29.8
Millet ...	0	—	—	—	—	—	—	—	65	349	8	13	54	—	1,685	2,109	11	13	12	—	2	—	237	264	31.4
Rice ...	0	—	—	—	—	—	—	—	4	—	—	1	1	2	67	71	7	—	—	1	4	5	101	111	16.5
Maize ...	1	—	—	—	—	—	6	6	2	—	3	11	—	—	22	36	1	—	1	2	—	—	8	11	13.2
Sugar Cane	0	—	—	—	—	—	—	—	2	—	—	—	—	—	20	20	3	—	—	—	—	—	22	22	8.4

P—*Proceras* spp.

B—*Busseola* spp.

S—*Sesamia* spp.

E—*Eldana* spp.

Rh—*Rhinaphe* spp.

O—Other genera and species yet to be identified principally pupae.

At Kwale the results showed that Agrocide 2 tends to give some control but owing to the large variation over the experiments the results were not significant.

In palatability trials on the yams from the Kwale experiment, there was a slight increase in tainted, but not rotten yams as between Control, D.D.T., diluted Agrocide 2 dust, Agrocide Wettable wash and Agrocide 2, in that order. These again were not significant.

STUDIES OF THE BIOLOGY AND CONTROL OF CAPSID PESTS OF CACAO—J. R. G. Sutherland

Three major pests of cacao belonging to the family Miridae (Capsidae) have long been recognised. They belong to the genera *Sahlbergella, Distantiella* and *Helopeltis*, and appear to be of decreasing importance in that order. *Sahlbergella*, in particular, attacks cacao plants throughout their lives and is capable of damaging a mature tree so that it will not produce fruit.

The Director of Research, West African Cacao Research Institute, suggested in April 1951 that insecticidal dusting during certain critical seasons might be effective in reducing capsid populations throughout the year. Accordingly, it was decided to treat a series of eight plots in Ondo and Ibadan Provinces during August 1951, leaving appropriate controls adjacent to each. This proved impossible because of late delivery of the dusting equipment. Population counts, as opposed to collections, were maintained from June, although dusting did not begin until early September.

Past records had indicated that characteristic increase of the capsid population tends to occur during the small dry season, which is ideal for dusting purposes. In 1951, however, the rainless period did not extend in to September, and rainfall often took place soon after dusting. Such rainless periods as occurred in August were wasted because of the non-arrival of dusting stores. It was decided after two treatments in September, carried out under uncertain conditions, to defer others until the weather should stabilise, though continuing the studies of capsid biology and of other insects present.

It was evident that each dusting usually reduced the capsid population of each treated plot, at least temporarily. The effect was delayed somewhat with both B.H.C. and D.D.T., the two insecticides used. The reduction in populations continued for periods of about thirty days. Freedom from Capsid attack soon reduced the typical "blasted" condition commonly associated with this pest, as new flushes appeared, though the numbers of dustings applied were usually insufficient or their timings unsuitable to maintain a permanent improvement in the appearance of all the plots. Instead there was usually a deterioration in appearance with the increase in the *Sahlbergella* population as the residual effect of the insecticide wore off. The insects were observed to feed principally on the more succulent stems bearing new flushes.

These preferred feeding grounds were usually much more numerous in treated than in untreated plots, probably owing to temporary insecticidal protection; however, as soon as the residual effect began to disappear, *Sahlbergella* population in treated plots tended to return to the levels of the untreated controls, and even to surpass them. The flushes often suffered damage before the older vegetative parts, and plants which had recently presented a thrifty appearance began to show "blast" in a matter of days.

This latter effect frequently gave the appearance of heavier damage in a treated plot until it was compared tree by tree with the control plot. Even then, in some cases, capsid damage seemed to be out of all proportion to the number of insects involved.

The results obtained to date indicate a reduction in capsid populations and an increase of pod production after two or more applications of either B.H.C. or D.D.T. dust. The investigation is being continued.

Jepson (1951). Plant. Prot. Overseas Rev. *2* : 2 : 21.

SURVEY OF MEALY-BUGS ON COCOA IN WESTERN REGION—

J. R. G. SUTHERLAND

At the suggestion of the Director of Cacao Research, West African Cacao Research Institute, a limited survey of mealy-bugs (*Pseudococcidae*) on Cocoa was begun in June 1951. The object was to widen the knowledge of their distribution by species throughout the cacao-growing areas of Western Region, and of their habits, particularly with regard to the presence or absence of attendant ants, and of ant-made paper-like shelters known as cartons.

Considerable data have been collected, and partly analysed. The species distribution is given in Table 8 and ant association findings in Table 9.

Table 8.—Summary of Results of Survey of Mealy-Bugs on Cacao 1951

Province	*No. of Localities*	*Species*	*No. of Colonies*	*Total No. of Insects*	*Percentage of Colonies*	*Average No. of individual Colony*
BENIN ...	3	*Pseudococcus citri*	41	364	48.8	8.9
		Ferrisiana virgata	37	140	44.0	3.2
		Pseudococcus concavocerarii ...	6	19	7.1	3.8
ONDO ...	10	*Pseudococcus citri*	283	1,506	72.4	5.3
		Pseudococcus njalensis... ...	29	151	7.4	5.2
		**Pseudococcus* sp. nr. *celtis* ...	27	70	6.9	2.6
		Ferrisiana virgata	18	53	4.6	2.9
		Pseudococcus concavocerarii ...	17	31	4.3	1.8
		Pseudococcus bukobensis ...	13	47	3.3	3.6
		Other Species	4	11	1.3	2.8
IBADAN ...	23	*Pseudococcus citri*	379	905	48.8	2.4
		Pseudococcus njalensis ...	251	3,222	32.9	12.8
		Pseudococcus bukobensis ...	45	120	5.0	2.7
		**Pseudococcus* sp. nr. *celtis* ...	27	95	3.5	3.5
		Ferrisiana virgata	31	80	4.1	2.6
		Pseudococcus concavocerarii ...	30	59	3.9	2.0
		Other Species	10	19	1.3	1.9
		Totals	1,248	6,892		

N.B.—All forms identified to species are proven vectors of at least one Nigerian virus or strain of swollen-shoot pathogen.

*Provisional identification.

Table 9.—Association of Ants and Cartons with Mealy-Bugs on Cacao 1951

Ant Genera and Subgenera	*P. citri*	*P. njalensis*	*P. bukobensis*	*P. longispinus*	*P. concavocerarii*	*P.* sp. nr. *celtis*	*P. virgata*
Crematogaster							
(*Crematogaster*) sp.	*x	c*x	*	*	c*x	c*	*
(*Decacrema*) sp.	c*x	c*	c*	*	*	*x	*
(*Orthocrema*) sp.	c*	*	*	*	*	*	*
(*Sphaerocrema*) sp.	c*x	c*	*x	*	*	c*x	*
Tapinoma sp.	c*x	*	*	*	*	*	*
Atopomyremex sp.	c*x	*	*	*	*	*	*
Cantholepis sp.	*x	*	*	*	*	*	*

Symbols of Observations : x=Colonies with ants only ; c=Ants and Cartons ; *=Colonies without ants.

This work is in continuation of that done by West African Cacao Research Institute personnel between 1945 and 1949. Since only a limited time has been spent on it, due weight of this factor must be given to the conclusions which have been drawn. Table 8, for instance, shows that 1,248 colonies of mealy-bugs were recorded, comprising a total of 6 892 individuals. Strickland (1951A) examined 276,844 *Pseudococcids* and concluded that the vast majority of the known vector species (1951B) present in the Gold Coast are *Pseudococcus njalensis*, Laing. He indicated that the proportion of *P. Njalensis* to other *Pseudococcid* species decreased from Sierra Leone toward Western Nigeria. The data presented here suggest that *P. njalensis* shows some three-quarters of the Gold Coast frequency of occurrence in those areas of Ibadan Province from which collections were made. These collections were made 107 from seven localities in the known swollen-shoot area and 144 from sixteen localities outside it.

It is worthy of note that *P. njalensis* shows great prolificacy in Ibadan Province, to which swollen shoot is confined at present. The numbers of individuals per colony inside the declared swollen shoot area are 12.3 and outside 13.2.

From Posnette's figures (1950), *P. citri* seems to be the most efficient of all the vectors for which records are available with Nigerian strains. *P. bukobensis* is of a similar order of vector capacity, and *P. njalensis* and *Ferrisiana virgata* seem to be of a like efficiency. These are based however, on gross averages, and it must be noted that all four of these species have failed to transmit the Asalu virus, while *F. virgata* has failed to transmit one other. The Akanran virus has not been tested with *P. citri*. Neither has the Olanla 0, nor the Alaparun been tested with *P. celtis*. The *P. celtis* group are third in number present in Ondo Province according to Table 7, and appear to be the species which is encountered next as frequently as *P. njalensis* in Ondo Province. Its status as a vector should be further studied.

The study of ant associations has revealed that (Table 9) *Orthocrema*, which has not been recorded previously as an ant-tending genus, was observed making cartons for *P. citri*. Crematogaster (*Crematogaster*) spp. appear never to make cartons for *P. citri*, although they do for *P. njalensis*, *P. concavocerarri* and the *P. celtis* group. They frequently make cartons for *P.* sp. nr. *celtis* a fact which might conceivably have considerable influence on the biotic potential of the species, and hence upon its vector efficiency from the numerical point of view. This species also appears to be the third-best served for ant-protection among the mealy-bugs reviewed here. As usual, *F. virgata* was not found to be ant-attended. At the other extreme, *P. citri* seems to be attended at one time or another by all the species of ants found so far observed to be associated with mealy-bugs in Nigeria.

The ants recorded in Table 9 are not necessarily the only ones on trees harbouring mealy-bugs ; they are those which appear to be actually associated with Pseudococcids.

Strickland (1951c) indicates a lesser number of genera of ants attending mealy-bugs than has been recorded here. A much broader and more intensive survey of the cacao growing area would be desirable. It is quite possible that a few years of work of this nature may lead toward making a confident forecast year by year of the areas likely to be affected by swollen shoot disease.

STUDIES OF THE BIOLOGY AND CONTROL OF SHOT-HOLE BORERS ON COCOA SEEDLINGS—J. L. Gregory

Work done between 1945 and 1950 indicated that cocoa seedlings growing under conditions of insufficient shade and water could be protected in some degree from attack from shot-hole borer, by insecticidal painting of the lower part of the stem. Statistical trials of two insecticides in two different media, were laid down in July.

It has been generally considered that the pest responsible for the characteristic damage to growing seedlings was *Coccotrypes pygmaeus*, Eich. Determinations made by the British Museum of the limited amount of insect material available around Ibadan at the time showed that three species of two genera were involved, none of which was *Coccotrypes*. Therefore, the trials were suspended, and it was hoped to begin biological studies in December, when insect material would be more readily available, and test conditions more realistic.

In the meantime, preparations had been made for large-scale empirical field trials, using a persistent insecticidal paint against both shot-hole borers and capsids on young cocoa. The results of these were most disappointing. Investigation of plant material after severe and widespread damage had been reported, showed that there was a high incidence of attack by several additional species of borer, as well as damage from the formulation itself.

The following beetles found attacking cacao seedlings have been identified by the Commonwealth Institute of Entomology :

FAM. Scolytidae :

Stephanoderes polyphagus, Egg.
Stephanoderes theobromae, Egg.
Stephanoderes sp.
Hypothenemus ater, Egg.
Hypothenemus subvestitus, Egg.
Xyleborus compactus, Eich.
Xyleborus sp.

FAM. Bostrychidae :

Micrapate neglecta, Lesne.
Xyloperthodes discedens, Lesne.

Two experiments on the biology of the pests are being investigated. The object of the first is to determine under what conditions beetle attack on, and breeding in, cacao seedlings takes place. Seedlings in the Botanists nursery have been divided into two groups, one being watered daily, and the other weekly. From each of these two group of seedlings, samples are being taken at monthly intervals with the object of studying :

(*a*) whether boring and egg laying take place naturally on healthy seedlings ;

(*b*) whether beetle attack commences only when the water balance of the plant is affected :

(*c*) the time of the year when seedlings are normally attacked, and

(*d*) whether beetle attack and breeding occur on healthy plants but only develop to serious proportions when the growth of the seedling becomes affected.

Posnette (1950). Ann. App. Biol. *37* : 381.
Strickland (1951A). Bull. Ent. Res. *41* : 731.
Strickland (1951B). Ibid. *42* : 72.
Strickland (1951C). Bull. Ent. Res. *41* : 728.

A second experiment is being carried out on mature cacao trees at Moor Plantation. A number of twigs on mature cacao trees are being partially cut through at monthly intervals so as to cause the slow dying of the twig and to produce as closely as possible natural dying of the twig. Each batch of dead twigs is then being sampled at further monthly intervals and examined for borers. This should give some ideas of the relative numbers of beetles present in each month of the year and whether or not there is a rotation of species on dead and dying cacao twigs.

The results obtained from this experiment should be applicable, with certain reservations, to seedlings although it is possible that some differences may occur in the species attacking seedlings and mature cacao.

A survey of borers on cacao in the Western Provinces is being continued as other work permits. Few results are as yet available since the beetles which have been obtained in this survey have not yet all been identified.

The results obtained to date have been tabulated below. Table 10 shows the distribution throughout the year in several localities of adult beetles of all species which have been found attacking cacao. It is not intended that this table is complete, nor that *Hypothenemus ater*, for example, is only found at Apoje in December and January.

Table 10.—*Distribution of scolytid and bostrychid borers of cacao by species, locality and month.*

Species	*Akure*	*Apoje*	*Asha (Ijebu)*	*Ibadan*	*Ijebu-Igbo*	*Agbo-ola*	*Oko Adebisi*
Hypothenemus ater		Jan. & Dec.	Mar.			Feb.	July
Hypothenemus pusillus		Jan.		Jan.	Jan.		
Hypothenemus subvestitus		Jan.					
Stephanoderes theobromae		Jan.			Jan.		
Stephanoderes polyphagus		Jan.	April	Dec.	Jan.		
Stephanoderes sp.				Jan.	Jan.		
Micrapate neglecta			Mar.				
Xyleborus sp.	Dec.						
Xyleborus compactus				Dec.			
Xyloperthodes discedens		Jan.					

Subsequent identification of specimens already obtained will fill this table out considerably. It may well show that all species occur throughout the year on many host plants.

In Ceylon, attacks by *Xyleborus fornicatus* on tea are considerably less where the Nitrogen content of the soil is high. It may be useful therefore to test the effect of dressing of Ammonium sulphate, or other nitrogenous fertiliser to cacao seedlings either :

(*a*) as early as possible in the rainy season, soon after transplanting so as to give the plants a good start and get them well established before the rainy season ends, or

(*b*) towards the end of the rainy season so that the nitrogen has its maximum effect just as the rains are ending to help carry it through the dry season, or

(*c*) at both the above times.

Arrangements have been made with Cocoa Division to test this in the cacao establishment areas at Elepo. Observations are also to be made monthly there on the numbers and causes of deaths of seedlings. The assessment of results obtained from Elepo, where the physiology of the growth of cacao seedlings is being investigated, should indicate the optimum growing conditions for the elimination of borer attack.

Attempts are also being made to rear the Scolytids and Bostrychids involved in this problem on cacao twigs in the laboratory. So far only larvae have been produced, no adult beetles having yet emerged.

STUDIES OF THE BIOLOGY AND CONTROL OF CHRYSOPS SPP.—J. T. Davey

Studies of these vectors of *Loa loa*, which were begun at Oil Palm Research Station in 1946, have been continued and tentative plans have been made for further observations on a limited scale during this dry season, to be followed by experimental control measures in 1952.

Larvae of the two species known to be involved *C. dimidiata* and *C. silacea* are found only in certain characteristic and easily recognisable aquatic habitats. Pupation occurs in these habitats, and marked adult females have been recovered up to 1½ miles from breeding grounds where marking took place.

Of the chemicals reported in the literature to be attractant to Chrysops none tested has been found effective. Cattle used as bait animals have been found consistently more attractant than men against whom they were tested, and dark-coloured hair or skin more than light.

No males have yet been captured in the field despite extensive canopy collections and baiting. Neither copulation nor oviposition have been obtained in the laboratory.

Fuller reports of this project have now been published by Davey and O'Rourke (1951).

NEW PESTS RECORDED

Ninety-six species of insects have been recorded as having actual or potential pest status within Nigeria for the first time, during the period covered by this report. Some of these are species new to Nigeria; others are newly recorded from the economic plants involved.

Of the above the following are likely to be of importance :—

On *Cacao*, eight stem borers :

Micrapate neglecta, Lesne., *Xyloperthodes discedens*, Lesne., *Hypothenemus ater*, Egg., *Hypothenemus pusillus*, Egg., *Hypothenemus subvestitus*, Egg., *Stephanoderes polyphagus*, Egg., *Stephanoderes theobromae*, Egg., *Xyleborus compactus*, Eich.

On *Cauliflower :*

Plutella maculipennis, Curt.

On *Citrus* :

Aphis citricidus, Kirk.

On *Coconut* :

Platygenia barbata, Afzel—Larvae and adults boring in crown of coconut; *Oryctes rhinoceros*, *Oliv*, boring coconut.

On *Guinea-corn* and *Millet* :

Proceras ignefuscalis, Hmpsn., stem borer.

On *Kola* :

Phosphorus jansoni, Chevr.—Kola borer.

On *Oil Palm* :

Schizaphis cyperi, Kirk, on seedlings.

On *Rice* :

Rhinaphe vectiferella, Hav., stem borer.

On *Yam* :

Apomecyna flavoguttulata, Aur., boring in vines; *Gryllopsis notabillis*, W., *Gryllopsis scenicus*, Ss., *Scapsipedus marginatus*, Af., *Gryllulus lineaticeps*, W., *Gryllulus gracilipes*, Serv., *Gryllotalpa minuta*, Burm., *Gryllotalpa fossor*, Smd., *Gymnogryllus lucens*, W., all cutting vines.

MAINTENANCE AND RENEWAL OF DEPARTMENTAL REFERENCE COLLECTION OF INSECTS

During the 30-odd years which this collection has been in existence a total of over 35,000 insects, representing some 5,000 species has been deposited. The present numbers are about 12,500 and 2,500 respectively. The number of accessions during 1951-52 was approximately 1,000, including 310 species recorded in Nigeria for the first time. Some 300 species remain partially determined, and 750 undetermined.

COTTON PESTS IN NORTHERN NIGERIA—A. F. H. Baillie

Routine records of the incidence of pests and on the causes of crop loss were continued on standard observation plots at Samaru, Daudawa, Gusau, and Kontagora, and were begun at Yola in Adamawa Province. Records were also obtained from Mokwa.

A trial was held at Samaru to investigate the cycle of breeding and feeding of *Dysdercus superstitiosus* on a number of cultivated and wild host plants. Observations on this pest were also taken on wild hosts in the bush throughout the year.

Three insecticide trials were held during the season at Daudawa and Samaru using D.D.T. emulsion and a dust containing D.D.T., B.H.C. and Sulphur. The effect of different rates and dates of application on pests and yield were investigated.

Studies on the pupal periods of *Diparopsis perditor* and on the emergence and diapause of *Platyedra gossypiella* were continued.

Full details of the season's work have been published in the Empire Cotton Growing Corporation "Progress Reports from Experiment Stations, Season 1951-52".

PUBLICATIONS

DAVEY, J. T. *with* O'ROURKE, F. J. "Observations on *Chrysops silacea* and *C. dimidiata* at Benin, Southern Nigeria". Part I Ann. Trop. medicine and parasitology **45** : 30-37. 1951.

DAVEY, J. T. Part II. *Ibid.* **45** : 66-72.

DAVEY, J. T. Part III. *Ibid.* **45** : 101-109.

GREENWOOD, M. "Fertilizer Trials with groundnuts in Northern Nigeria", Empire Journ. Exper. Agric. **19** : 225-241. 1951.

GREENWOOD, M. *with* HAYFRON, R. J. "Iron and Zinc deficiencies in cacao in the Gold Coast", Empire Journ. of Exper. Agric. **19** : 73-86. 1951.

GREENWOOD, M. *with* DJOKOTO, R. K. "Symptoms of mineral deficiency in Cacao" Journ. Hort. Sciences (in press).

RUSSELL, T. A. "The vigour of some cacao hybrids" Trop. Agric. **29** : 102-106, 1952.

THOROLD, C. A. "The epiphytes of *Theobroma Cacao* in Nigeria in relation to the incidence of Black-pod disease (*Phytophthora palmivora*). Journ. Ecol. **40** : 125-142. 1952.

THOROLD, C. A. "Airborne dispersal of *Phytophthora palmivora*, causing Black-Pod disease of *Theobroma cacao*. Nature, **170** : 718, 1952.

WATERSTON, J. M. *with* RHIND, D. *and* DEIGHTON, F. C. "Occurrence of *Puccinia polysora* Underw. in West Africa" Nature, **169** : 631. 1952.

STAFF LIST OF RESEARCH WORKERS AS AT 31st MARCH, 1952

(Including Officers of the regional research stations, the Maize Rust Research Scheme, the Rice Research Scheme and the Empire Cotton Growing Corporation but not W.A.I.F.O.R.)

Senior Specialists

W. E. Freeman, B.Sc. (Lond.), A.R.C.S., A.I.C.T.A. (Resumed duty March 1952).	Senior Botanist (2).
T. A. Russell, B.Sc. (Lond.), A.R.C.S., A.I.C.T.A., Dip. Agric. (Cantab.). (On leave April 1951-Sept. 1951).	Senior Botanist (2).
J. M. Waterston, B.Sc. Ph.D. (Edin.), A.I.C.T.A.	Senior Botanist (2).

Specialists

J. R. G. Sutherland, B.Sc. Agric. (McGill)	Senior Entomologist (1), (2).
M. Greenwood, O.B.E., B.Sc., M.Sc. (Manchester), (Retired March 1952).	Temporary Chemist (2).
C. A. Thorold, M.A. (Oxon.), A.I.C.T.A. Resumed duty July 1951).	Plant Pathologist (3).
J. H. Gisborne, B.A. (Oxon.), A.I.C.T.A.	Botanist (2).
H. Irving, B.S.A., B.Sc. Agric. (Toronto). (Resumed duty May 1951).	Chemist (2).
J. T. Davey, B.Sc. (Bristol), A.I.C.T.A. (On secondment French Soudan, Oct. 1951).	Entomologist (2).
A. R. Maurer, B.S.A. (U.B.C.), M.Sc. (McGill). (On leave August 1951-January 1952).	Botanist (4).
J. L. Gregory, B.Sc. (Bristol), Dip. Agric. (Cantab.), Dip. Trop. Agric. (Trinidad). (On leave Sept. 1951-Jan. 1952).	Entomologist (2).
A. J. Vernon, B.Sc. Agric. (Reading)	Botanist (3).
G. M. Higgins, B.Sc. Agric. (Wales), Dip. Agric. (Cantab.). (Assumed duty Sept. 1951).	Chemist (4).
L. A. Heapy, B.Sc. (Saskatchewan). (Assumed duty October 1951).	Chemist (5).
J. M. L. Kowal, B.Sc. (Wales)	Agric. Development Officer (3).
3 Vacancies	Specialists (2).
3 Vacancies	Specialists (4)
2 Vacancies	Specialists (5).

Cocoa Soil Survey

H. Vine, B.Sc., Ph.D. (Lond.), A.R.I.C., A.I.C.T.A. (Seconded from Central Research Organisation).	Senior Chemist (1) and O/in-charge (3).
W. G. D. Walters, M.Sc. (Wales), A.R.I.C. (Assumed duty February 1951).	Temporary Soil Scientist (3).
V. J. Weston, B.Sc. (Wales), A.R.I.C. (Assumed duty September 1951).	Soil Scientist (3).
R. J. Montgomery, B.Sc. (St. Andrews), (Assumed duty December 1951).	Soil Scientist (3).

Empire Cotton Growing Corporation

H. E. King, B.Sc. (Agric.), Dip. Agric. (Wye) ... ... Cotton Breeder.

A. F. H. Baillie, B.Sc. (Wales), D.I.C. ... ... Cotton Entomologist.

J. Saunders, B.Sc. (Aberdeen). (Assumed duty September, 1951). Cotton Breeder.

Visiting Scientist (E.C.A. Scheme)

O. J. Webster, Ph.D. (April to December 1951) ... ... Agronomist.

Maize Rust Research Scheme R471

Vacant ... ... Chief Research Officer.

Vacant ... ... Maize Breeder.

Vacant ... ... Mycologist.

Rice Research Scheme R224

Vacant ... ... Rice Breeder.

Vacant ... ... Agricultural Officer.

Note.—(1) Retains title of Senior Specialist.

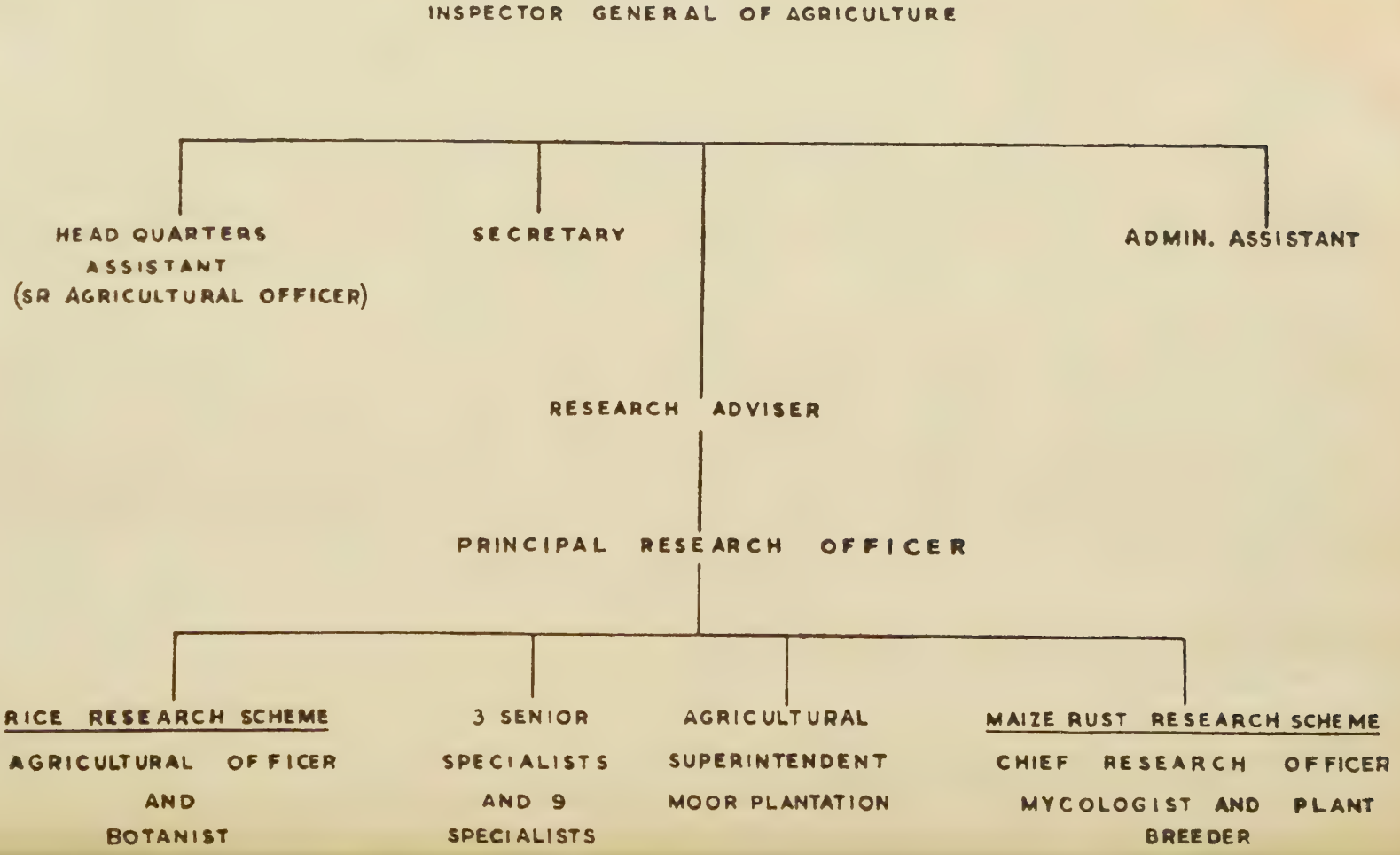
(2) Paid from Nigerian Funds.

(3) Paid from Western Region Development Funds.

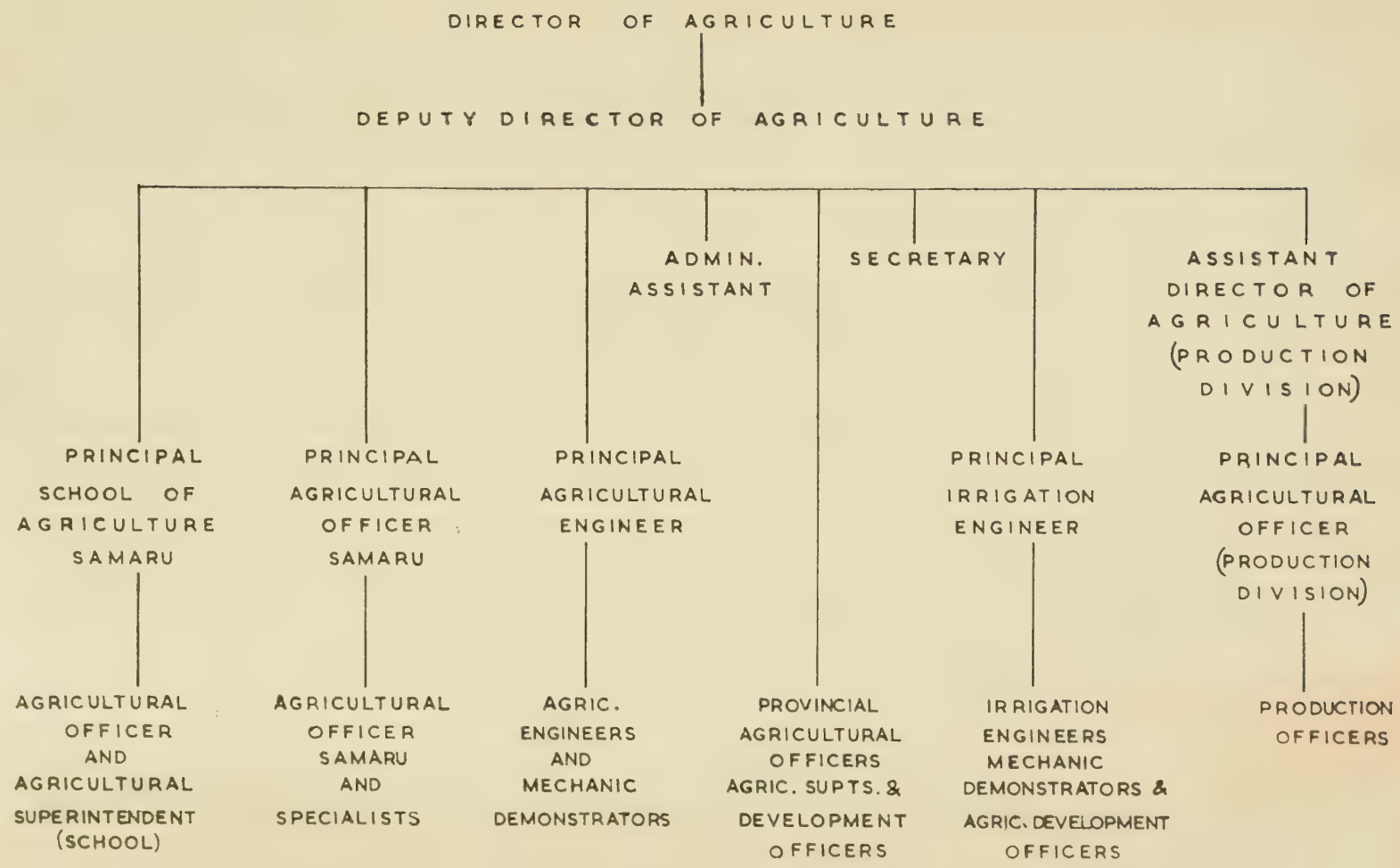
(4) Paid from Northern Region Development Funds.

(5) Paid from Eastern Region Development Funds.

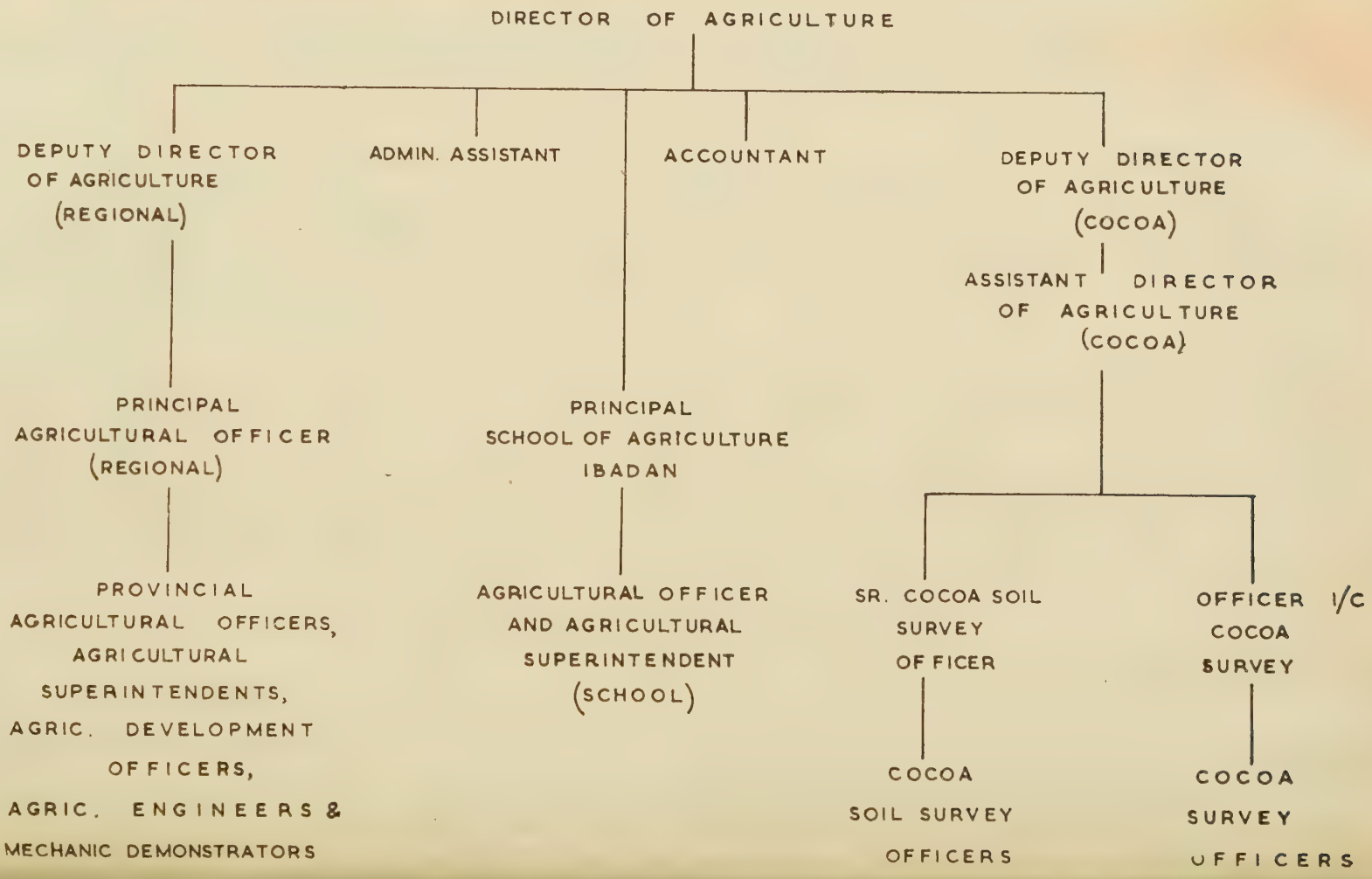
CENTRAL ORGANISATION OF THE DEPARTMENT OF AGRICULTURE AS AT 1:10:51



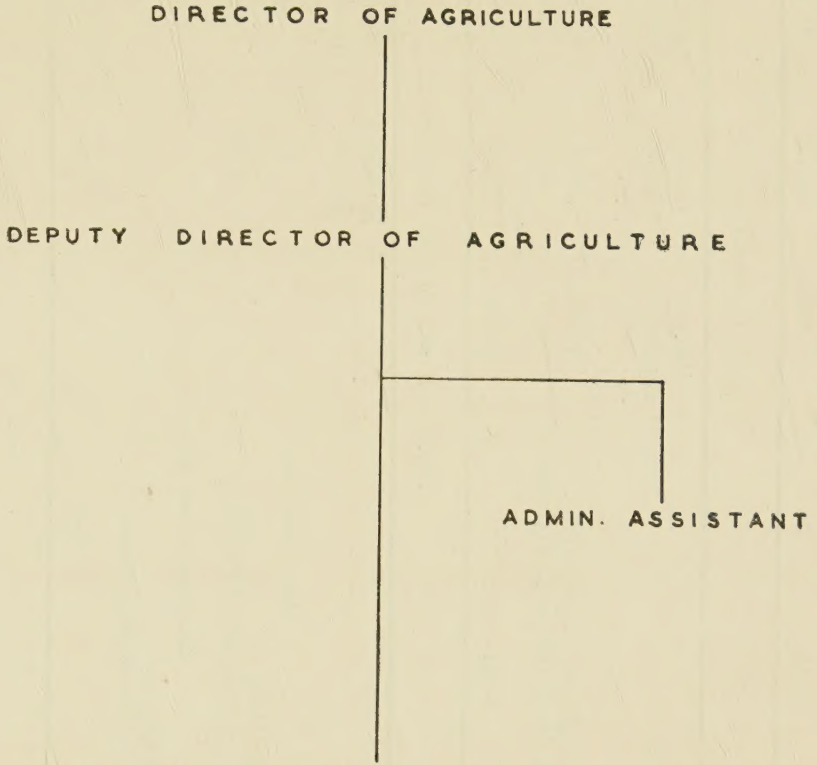
ORGANISATION OF NORTHERN REGIONAL DEPARTMENT OF AGRICULTURE AS AT 1:10:51



ORGANISATION OF WESTERN REGIONAL DEPARTMENT OF AGRICULTURE AS AT 1:10:51



ORGANISATION OF EASTERN REGIONAL DEPARTMENT OF AGRICULTURE AS AT 1:10:51



SUMMARY OF CENTRAL EXPENDITURE AND REVENUE FOR THE PERIOD 1ST APRIL, 1951 TO 31ST MARCH, 1952

Estimated Expenditure

	Personal Emoluments	*Other Charges*	*Special Expenditure*	*Total*
	£	£	£	£
Main Agriculture (Nigeria) ...	63,790	26,990	3,560	94,340
Agricultural Development (Nigeria)	8,810	5,110	6,800	20,720
Total ... ... £	72,600	32,100	10,360	115,060

Actual Expenditure

	Personal Emoluments	*Other Charges*	*Special Expenditure*	*Total*
	£	£	£	£
Main Agriculture (Nigeria) ...	49,092	25,817	3,581	78,490
Agricultural Development (Nigeria)	6,149	3,678	2,325	12,152
Total ... ... £	55,241	29,495	5,906	90,642

Estimated and Actual Revenue

	Estimated Revenue	*Actual Revenue*
Main Agriculture	£	£
Agege Dairy...	5,150	2,494
Sales of Agricultural Produce	1,200	1,121
Development and Welfare		
Seed Depot	—	41
Poultry Development Centre	—	326
Total ... ... £	6,350	3,982

GP Ibadan(Lagos)
1856(53)/354/1,150